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CLINICAL EVALUATION OF DENTAL RESTORATIVE MATERIALS

Final Report

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This final report represents the results of controlled clinical studies involving 5,727 dental restorations in 1,154 patients which were placed under recorded standardized conditions and were assessed annually for 19 years. The restorations were evaluated by the PHS criteria and reasons for failure were also recorded. The longevity and modes of failure of composite resins, amalgam, base metal, and gold alloys were assessed by use of an Actuarial Life Table Survival Analysis procedure. The median survival time for anterior composites was 13.5 years, as compared to 12.1 years for Class I and 7.1 years for Class II composites. Caries, fracture and wear accounted for 75% of the related reasons for failure of Class II composites. The median survival time for Class I and II amalgams was >19 and 13 years, respectively. There was no difference between the survival function of polished and unpolished alloys, nor was there any difference between high and low copper composition alloys.

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TABLE OF CONTENTS

SECTIONS

LIST OF ILLUSTRATIONS

LIST OF TABLES

SUMMARY

This final report presents the results of a five year controlled clinical study which was supported by Contract No. DAMD17-84-C-4059 between the U.S. Army Medical Research and Development Command (MRDC) and the University of the Pacific, School of Dentistry. The objective of this broad research program was to evaluate the long term performance of popular dental filling materials such as, amalgam, composite resin, and base metal alloys which were placed under previous periods of support by MRDC. In addition, the study reported on the incidence of nickel sensitivity in dental patients, and the short term performance of a test hydrophobic composite resin and a new castable ceramic fixed prosthodontic material.

Over a 19 year period, this dental clinical research facility has collected vital information on a total of 5,727 restorations which were placed under recorded standardized conditions and annually assessed. The restorations which were placed in 1,154 patients represent a broad spectrum of 77 different study restorative agents. This facility was the first of its type in the world to utilize modern computer technology to support the unbiased execution, recording, and chair-side analysis of the many factors that play a role in the longevity of dental restorative procedures.

Rather than characterize the clinical performance of specific proprietary restorative agents, this facility elected to examine the underlying modes of failure and the longevity of broad categories of dental materials. For the first time in clinical biomaterials research, we used a statistical approach of Survival Analysis which utilized the construction of Actuarial Life Tables for each category of restorative material. On this basis, we were able to determine the comparative longevity of anterior and posterior composite; whether posterior composites compare favorably with dental amalgams; if there was a difference in the longevity of Class I and Class II restorations, whether the current change from low copper alloys to high copper alloys resulted in a change in longevity; if polishing an amalgam restoration increased its longevity, etc. Finally the observed modes of failure can serve as a rational basis for the modification of the formulation to improve specific mechanical and physical properties or clinical operational procedure to enhance the longevity of dental restorative procedures.

Analysis of the pooled reasons for failure revealed that 10.7 percent of all restorative agents required replacement for reasons which were totally unrelated to the filling material, i.e. fracture of the adjacent tooth, nonapproximating caries, need for endodontics, crowns, etc. For composite resins, caries is still the prime mode of related failures, accounting for 33.3 - 33.9% of anterior and posterior restorations. The median survival time for posterior composites was 8.6 years as compared to 13.5 years for anterior restorations. A comparison of the survival of Class I and Class II posterior composites showed a very significant difference, i.e. 12.1 years for Class I's vs. only 7.1 years for Class II's. Caries, fracture, and wear accounted for 75% of the related reasons for failure of Class II composite restorations.

In contrast, median survival time for Class I and II amalgam alloys was in excess of 19 years and 13 years, respectively. Caries and fracture accounted for 67 percent of the related causes for replacement in both classes of restorations. In the case of Class II's, fracture played the predominant role (39.7%) and for Class I's, caries was the prime mode of failure (43.2%). Interestingly, we found that there was no significant difference in the longevity of polished and unpolished amalgam alloys. Since polishing amalgam alloy restorations does not increase the restoration's longevity, the increased time and expense of this procedure is not warranted.

Recent studies of the relatively short term performance of high copper containing alloys have demonstrated improved margins over the previously used low copper containing amalgam alloys. It had been assumed that this significant enhancement of this property would result in increased longevity. Examination of the documented reasons for replacement revealed that the percentage of related marginal failures was relatively low for the high copper amalgam alloys as compared to the low copper alloys, i.e. 10.2% vs. 44.2%. However, there was a significant increase in gross fractures with the high copper amalgam alloys. Hence, examination of the plotted survival functions curves for the high and low composition amalgam alloys, showed no significant difference in ultimate longevity.

A comparison of the longevity of posterior composite resins and dental amalgam alloys revealed that the incidence of related failures was approximately three times greater for the composite resin, 26.2 vs. 9.1%. The median survival time for amalgam alloys was 9.2 years, as compared to only 4.7 years for posterior composites. Therefore, the election to utilize a composite resin for the restoration of posterior teeth should be based upon a patient's desire for esthetics, or where documented hypersensitivity to the constituents of dental amalgam precludes its use. In both instances the patient and clinician should be aware of the 50% reduction in longevity and the need for yearly re-examinations.

A comparison of the longevity of base metal and a conventional gold alloy revealed a very similar low incidence of related failures, i.e. 9.9 - 10.6%. Examination of the plots of the survival functions of these two fixed prosthodontic materials showed no distinguishing differences. The 75% survival times for the base metal and gold alloys were 11.4 vs 11.1 years, respectively. It would appear that the relatively low cost base metal alloys are viable alternatives to gold alloys as fixed prosthodontic restorative materials.

A retrospective epidemiological study was conducted to determine whether the there was a positive relationship between the dental use of these alloys and increased risk of developing nickel sensitivity. On the basis of dermal patch test data and the confirmed presence or absence of intra-oral nickel containing dental alloys, we did not find any correlation between the dental use of nickel containing base metal alloys and the increased incidence of nickel sensitivity. We did find that the female sensitivity to nickel sensitivity between the ages of 24-44 was 4.8 times that of other age groups. The incidence of nickel sensitivity was 9.7% for females and 0.8% for males.

The wear of posterior composites continues to play an important role in the failure of composite resins. Therefore, we developed a unique scale to accurately quantify occlusal loss of material. The "M-L" scale utilizes 18 micrometric defects and has a range of 0 to 1.000mm. The scale has a true zero point as its origin, and the ratio of any two scale points is independent of the unit of measurement. Hence the scale values (based upon an interval of 25 microns) may be analyzed by conventional parametric statistics. A calibration scheme utilizing sequential analysis has been established to assure uniformity in usage. This scale is now in use by clinical investigators throughout the country. Its use at the Patient Care Branch at NIDR has proven valuable to evaluate the wear of a posterior composite and a dental amalgam which was not discernible with a well accepted ordinal rating system (the PHS system).

A short term study of the clinical performance of an experimental hydrophobic composite resin was also conducted. The experimental resin was based upon a polyfluorinated oligomeric multifunctional methacrylate which was developed at the National Bureau of Standards. It was assumed that if such a hydrophobic resin could be developed it would be less susceptible to water assisted chemical degradation and marginal leakage. Accordingly, the accrued benefits might eliminate the need for acid etch procedure and resin bonding at the enamel margins. A relatively short term study (12 months) revealed that there does not seem to be any evidence that the hydrophobic nature of the test composite resin will eliminate the need for the acid etch and bonding procedures. In all five areas of assessment -- color match, marginal discoloration, anatomic form, marginal adaptation, and caries -- the control conventional BIS-GMA resin was either equal or superior to the clinical performance of the test hydrophobic material.

Finally, a relatively short term three year study was conducted of the clinical performance of a new castable ceramic material for use in fixed prosthodontics. On the basis of the data collected, this new material was extremely esthetic, possessed excellent marginal fit and biocompatibility, and there was no degradation of the superficial shading porcelain over the three period of observation. Fracture of the castable ceramic was the prime mode of failure. The incidence of fracture for molars was 35.3%, premolars 11.8%, and anterior teeth 3.5%. We found that when the thickness of the castable ceramic crown and attention to occlusion were carefully controlled in a subsequent study, the incidence of fracture was eliminated. It would appear that control of the thickness of the castable ceramic crown was a very important factor, especially under conditions of high occlusal loading.

Over the past years, our research laboratory (like many others) has concentrated its efforts on the evaluation of proprietary and experimental restorative materials by use of ordinal rating systems, the PHS system, ranked photographs, quantification of changes, etc. Although these techniques may show statistical differences among designated materials, over the relative short term, there is no evidence that the measured parameters are actually predictive of the material's ultimate longevity. In addition, these techniques characterize only the specific products tested and as the products are modified or withdrawn the results of the studies are short lived. Past efforts to reduce the incidence of marginal breakdown is an example of an improvement of only one parameter which had little influence on the amalgams' long term longevity. Finally, short term studies of *alleged performance parameters* may or may not provide information as to the actual modes of failure and rationale for improvements in future classes of materials to enhance longevity.

In conclusion, we would recommend that MRDC support retrospective epidemiological studies of the performance of restorative materials and encourage the development of well controlled prospective studies which are attentive to the retrieval of time dependent modes of failure.

FOREWORD

In conducting research using animals, the investigator(s) adhered to the "Guide for the Care and Use of Laboratory Animals," prepared by the Committee on Care and Use of Laboratory Animals of the Institute of Laboratory Animal Resources, National Research Council (NIH Publication No. 86-23, Revised 1985).

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THE UNIVERSITY OF THE PACIFIC
SCHOOL OF DENTISTRY

CLINICAL EVALUATION OF DENTAL RESTORATIVE MATERIALS

FINAL REPORT FOR THE PERIOD 10/83 - 09/88

This final report will present the results of a five year controlled clinical study which was supported by Contract No. DAMD17-84-C-4059 between the U.S. Army Medical Research and Development Command (MRDC) and the University of the Pacific, School of Dentistry and addressed the following research objectives:

I. To evaluate the long term clinical performance of amalgam, composite resin, and base-metal alloy restorations which were placed under previous MRDC contract support and to continue the retrospective epidemiological study of the incidence of nickel sensitivity in dental patients.

II. To evaluate the clinical performance of a test hydrophobic composite resin based upon a polyfluorinated oligomeric multifunctional methacrylate formulation as compared to a control BIS-GMA formulation for the restoration of anterior teeth.

III. To evaluate the clinical performance of a new castable ceramic material for use in fixed prosthodontics. Particular emphasis shall be placed upon the incidence of fracture, fit, and esthetic qualities of the restoration and permanence of the superficial stain and glaze.

I. LONG TERM CLINICAL EVALUATION OF DENTAL RESTORATIVE MATERIALS

1. DESCRIPTION OF THE PATIENT POPULATION

To-date, the dental clinical research facility in San Francisco has historical clinical data on the longevity and the causes for failure of a total of 5,727 dental restorations which were placed under controlled conditions in 1,154 patients. These restorations represent a diversity of dental restorative materials which are in popular use by dental practioners, such as dental amalgams, composite resins, base-metal and precious metal alloys and castable ceramic crown and bridge materials. These restorations were placed over a 19 year period under recorded standardized conditions of placement and annual assessment.

The patient population was selected from adult male and female volunteers residing in the San Francisco area who required routine dental care. No compensation was paid to the patients and dental care was provided at no cost to the patient. All patients were informed of the experimental nature of their treatment and were required to sign Patient Informed Consent forms which were approved by a Human Use Institutional Review Boards at Letterman Army Institute of Research and the University of the Pacific, School of Dentistry. Selection of patients for participation in the studies was based upon documented clinical and radiographic evidence of dental pathology. All patients were required to be adults in general good health, who resided in the San Francisco area, and who would be willing to return on an annual basis for follow-up evaluation by a team of trained examiners. The majority of patients in the various studies were civil service and retired military personnel and their families.

Table 1

RACIAL AND SEXUAL DISTRIBUTION OF PATIENT POPULATION

-RACE-

SEX	*CAUCASIAN*	*BLACK*	*HISPANIC*	*ASIAN*	*TOTAL*
MALES	469	92	12	67	640
FEMALES	318	114	6	76	514
TOTAL	787	206	18	143	1,154

Table 2

MEAN AGE DISTRIBUTION OF PATIENT POPULATION - YEARS

-RACE-

SEX	*CAUCASIAN*	*BLACK*	*HISPANIC*	*ASIAN*	*OVERALL MEAN*
MALES	*47.6*	*44.7*	*50.9*	*43.7*	*46.8*
FEMALES	*44.6*	*43.8*	*45.7*	*43.8*	*44.3*
OVERALL MEAN	*46.4*	*44.2*	*49.2*	*43.8*	*45.7*

As shown in Table 1, 55.5 percent of the 1,154 patients were males and the remaining 45.5 percent were females. Caucasians represented the majority of the patient population, i.e. 68.2 percent, with other ethnic groups comprising the remaining 31.8 percent. With the exception of the Hispanic group, which was very small, the distribution of male and female patients and the various ethnic groups was very similar.

The overall mean age of the entire patient population, shown in Table 2, was 45.7 years. The mean age of male patients was consistently slightly higher than the mean age of female patients for all racial groups, which ranged from a low of 43.8 years for Asian patients, to a high of 49.2 years for Hispanic patients. The overall mean age for males was 46.8 years, as compared to an overall mean age for females of 44.3 years. There were only minor differences in the mean age distributions of the various sexual and ethnic groups involved in the entire patient population base. Therefore, it would appear that, with the exception of the small group of Hispanic patients, the overall patient population involved in the various studies were very homogeneous in regard to the age and proportion of male and females in the various ethnic groups.

Letters were sent to all patients involved in our controlled clinical studies informing them of the termination of the program and unavailability of further dental treatment after September 30, 1988. Each patient was encouraged to call the clinical research facility for an appointment if they desired an examination and/or further dental care prior to that date. In addition, each patient was also provided with a franked self-addressed postal card which acknowledged receipt of the notification of termination and provided patients the opportunity to request an appointment for examination and dental treatment. Copies of these notification letters and returned postal cards were included in each patient's official dental record.

2. DESCRIPTION OF THE MANAGEMENT OF THE CLINICAL DATA BASE

In addition to the traditional written dental records, the operation of the clinical research facility has been augmented by an integrated clinical research computer system which was developed and implemented under MRDC contract support. The hardware designed to support the clinical facility utilizes a Wang 2200 MVP mini-computer which consists of:

1 Wang 2200 MVP mini-computer central processing unit
5 Wang multiplexed interactive CRT terminals
2 Wang floppy disk drives
1 Wang fixed/removable disk drive storage unit (10 Megabytes)
1 Wang fixed/removable disk drive storage unit (80 Megabytes)
1 Wang high speed matrix printer
1 Wang daisy wheel printer

The associated biomaterials testing laboratory which was designed to provide pre-clinical testing of the mechanical and physical properties of candidate clinical restorative materials, was supported by the following integrated computer hardware:

1 Wang 2200 VP mini-computer central processing unit
3 Wang multiplexed interactive CRT terminals
2 Wang floppy disk drives
1 Wang fixed/removable disk drive storage unit (10 Megabytes)
1 Wang multi-channel analog/digital converter
1 Wang moderate speed matrix printer
1 Wang 3 pen drum plotter

Under support by the U.S. Army Medical Research and Development Command and the U.S. Army Institute of Dental Research, a new five (5) chair A-Dec equipped dental clinical research facility was recently completed in 1987. The completely computer augmented research facility was designed so that one (1) Wang multiplexed interactive CRT terminal could be shared by two adjacent clinical treatment units. In addition, one CRT terminal was available for use in the patient appointment reception area and another in the isolated climate controlled central computer room.

The computer software was designed to provide direct chair-side entry and analysis of all clinical data. Utilizing an interactive dialog, these programs provided for the entry of patients' demographic information, dental pathology, needs for diagnostic procedures, specifics of dental care rendered, and finally, the unbiased control and recording of the evaluation of the performance of each material. Each test and control restorative material was assigned a unique five digit number. At the beginning of each day, the code numbers of the study materials which were to be placed that day were entered into the computer's memory. As each patient required restorative care, the computer was programmed to utilize a random scheme for designation of the actual material to be utilized for each restoration, thus *eliminating the possibility of operator bias in the selection of test materials.*

Following an established protocol, the appropriate restorative procedure was completed and the specifics of the procedure were then entered into the computer to record:

1. Patient's name
2. Patient's identification number
3. Tooth number
4. Surfaces restored
5. Date of placement of the restorative material
6. Operator's name
7. Use of photographs, yes or no
8. Other factor, i.e. use of pins, cement base, etc.

The combination of information field numbers 1-5 provided a unique non-repetitive key which the computer could utilize for subsequent data retrieval and analysis. One week after placement of the restorative materials, base-line examinations were performed by two trained and calibrated dental examiners utilizing criteria based upon a well recognized ordinal rating system, i.e. the PHS clinical rating system as developed by Ryge and Cvar.

Table 3

CODES FOR FAILED RESTORATIONS

RELATED FAILURES	*CODE*
Related Caries	J
Related Fracture	K
Open Margins	L
Marginal Leakage	M
Excessive Wear	N
Unesthetic Color	P
Pulpal Hyperemia	Q
Inadequate Contact/Contour	R
Other - Related	S
UNRELATED FAILURES	*CODE*
Unrelated Caries	T
Unrelated Fracture	U
Endodontic Treatment	V
Fixed Prosthodontics	W
Tooth Missing	X
Other - Unrelated	Y

The PHS criteria were modified to provide for the recording of reasons for failure of restorative materials. In the event a restoration required replacement the code values (as listed in Table 3) were utilized to categorize the primary reason for failure. These codes and the date of failure were entered into the patient's computer record.

To eliminate evaluation bias, the following procedure was utilized. The computer was provided with the code numbers of all materials to be evaluated. When the patient's name was entered, the computer was programmed to determine which teeth were restored with the materials to be evaluated. Accordingly, the computer would display only the teeth numbers of interest to the evaluators, *without displaying the identity of the material.* The first examiner then had the opportunity to enter his evaluation codes for the displayed teeth numbers. After all assessments were completed, the CRT screen would clear, instruct the first examiner to leave the room, and allow the second examiner to make his assessments of the same teeth, *without knowledge of the first examiner's ratings.*

If there was a disagreement between the examiners, the CRT screen would display the tooth numbers and areas of disagreement to the two examiners. They would then confer to arrive at a consensus rating. At the termination of the evaluation session, the computer would then provide a summary of the disagreement between examiners, the direction in which consensus was arrived at, and the possible need for recalibration of examiners. After the base-line evaluations were performed, the evaluation procedures were again repeated on an annual basis in the same unbiased manner, *without knowledge of the identity of the material, each examiner's individual ratings, nor the prior periods' assessments.*

Table 4

DISTRIBUTION OF RESTORATIVE MATERIALS CODES

TYPES OF MATERIALS	*STUDY*	*GENERIC*	*TOTAL*
Composite Resins	28	16	44
Amalgam Alloys	34	12	46
Base-Metal Alloys	10	7	17
Gold Alloys	2	1	3
Castable Ceramics	3	1	4
TOTAL	77	37	114

As each type of restorative material was utilized for a particular controlled clinical study it was assigned a unique five digit number. The first three digits were utilized to identify the classification of material, i.e. 103xx = High Copper Amalgam Alloy, DISPERSALLOY. The last 2 digits were employed to identify a unique variable associated with the material's utilization in the controlled clinical studies, i.e. xxx03 = Unpolished Amalgam Alloy. If the last two digits were zeros it would indicate that the material was a generic material, which did not participate in any particular study and was utilized for the routine treatment of dental pathology which was necessary to maintain patient participation in the research program, i.e. 10300 = Generic High Copper Amalgam Alloy, Dispersalloy. Table 4 is a summary of the distribution of the current restorative material study and generic codes.

Table 5

DISTRIBUTION OF THE NUMBER OF RESTORATIONS PER RESTORATIVE MATERIAL

TYPES OF MATERIALS	*NUMBER*
Composite Resins	1,569
Amalgam Alloys	1,727
Base-Metal Alloys	365
Gold Alloys	104
Castable Ceramics	126
STUDY TOTAL	3,891
GENERIC TOTAL	1,836
GRAND TOTAL	5,727

Table 5 summarizes the number of restorations which were placed in controlled clinical studies and the number of generic restorations which were also placed. Analysis of this data revealed that approximately 32 percent of the total number of restorations placed were generic materials which were required for the treatment of dental pathology necessary to maintain patient interest and participation in the clinical research program.

A broad range of computer programs have been written for the Wang 2200 MVP mini-computer to facilitate the descriptive and analytical statistical analysis of the performance of these 5,727 restorations which were placed in 1,154 patients over the past 19 years. The dental clinical information in this computer data base represents one of the few resources of its kind in the world. In light of the termination of support for this program by the National Institute of Dental Research, and the uncertainty of the disposition of the Wang Computer and other capitalized equipment, a significant effort was made to transfer the clinical data base from the current highly specialized mini-computer to the more popular IBM micro-computer format.

Accordingly, conversion programs have been written by the Principal Investigator which enable porting of the entire data base and all other supporting operational programs to an IBM-XT micro-computer format. The data base and translation programs require a minimum of 640 Kilobytes of RAM memory, 15 Megabyte of Winchester Hard Disk storage, and a LaserJet printer as an output device. This report was written utilizing the IBM-XT ported version of the original Wang data base.

3. DESCRIPTION OF THE ANALYTICAL PROCEDURES TO ASSESS CLINICAL PERFORMANCE

As shown in Table 4, over the past 19 years this clinical research facility has placed 77 different Study Materials, each of which involved approximately 50 replications or restorations. Statistical analysis of the distribution of the PHS criteria, as developed by Ryge and Cvar, proved useful for the relatively *short term* analysis which compared the clinical performance of one material to another. However, in order to evaluate the *long term* clinical performance and to assess the longevity and causes for failure other analytical procedures were required.

To facilitate this analysis, computer programs were written which surveyed the entire data base and utilized the reasons for failure described in Table 3 to prepare a distribution of reasons for failure on an annual basis, throughout the life of the study. This distribution was then utilized to construct a *Life Table* and and *Survival Analysis* of the long term performance of each category of restorative materials. Construction of a survival function made it possible to calculate the median survival and the 75% quantile survival for each category of restorative material. As will be described in detail later, these procedures, ignored individual brand names of materials, and provided vital information on the longevity and reasons for failures of broad categories of restorative materials, such as a comparison of long term performance of polished versus unpolished amalgam alloys or whether there was a difference between high copper versus low copper amalgam alloys, Class I versus Class II restorations, posterior composites versus amalgam alloys, etc.

The distribution of the reasons for failure of all amalgam alloys (Table 6) and its companion Life Table and Survival Analysis of All Amalgam Alloys (Table 7) on the next two pages, best illustrate the statistical procedures which were utilized.

The series of 31 five digit code numbers in Table 6 represents the entire spectrum of amalgam alloy formulations which were evaluated over the nineteen years of support by NIDR. The capital letter column headings represent the codes for failed restorations previously defined in Table 3. Code letters "J" through "S" represent "Related Failures" which may be attributable to factors associated with the restorative material. In contrast code letters "T" through "Y" represent "Unrelated Failures", i.e. failures due to factors not associated with the restorative material. The column designated "OK" signifies the number of restorations which were examined and deemed functional at a particular evaluation period but were not evaluated at later recall periods because of withdrawal by the patient. The "Total" column represents the total of all restorations which either failed or were functional at each yearly period. The "%" column represents the annual percentage of the grand total number of restorations which either failed or were functional at that period.

The row "Totals" reflects the total number of restorations which were judged to have failed for the designated coded reasons. The first "%" is the percentage of the grand total number of restorations attributable to each mode of failure. The second "%" is the percent of "Related" or "Unrelated" reasons.

Table 6

DISTRIBUTION OF REASONS FOR FAILURE - ALL AMALGAM ALLOYS

MATERIALS = ALL AMALGAM ALLOYS

CODES = 10301 10302 10303 10306 10311 10401 10402 10701 11101 11201 11301 11309 12102 12104 10501 12402 10304 11302 10305 10309 10310 11102 11103 11202 11303 11306 11307 11308 12101 12103 12401

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
1	-	2	2	-	-	-	-	1	3	2	5	3	6	6	1	240	271	15.7
2	6	15	4	-	-	-	-	-	2	2	5	2	8	3	4	103	154	8.9
3	12	13	17	-	-	-	1	-	2	4	7	-	1	2	7	87	153	8.9
4	6	5	8	1	-	-	-	-	2	2	5	-	1	1	10	136	177	10.2
5	10	6	4	-	-	-	-	-	3	7	8	-	3	6	5	232	284	16.4
6	3	3	-	-	-	-	-	-	-	2	2	3	2	-	2	110	127	7.4
7	3	4	-	1	-	-	-	-	-	-	2	-	2	-	5	73	90	5.2
8	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	73	77	4.5
9	2	1	-	-	-	-	-	-	-	2	5	-	1	2	1	91	105	6.1
10	1	1	1	-	-	-	-	1	-	3	2	-	1	-	1	38	49	2.8
11	1	2	-	-	-	-	-	-	-	2	1	-	2	-	3	73	84	4.9
12	-	2	-	-	-	-	-	-	-	4	-	-	4	1	3	55	69	4.0
13	-	-	-	-	-	-	-	-	-	-	-	-	2	4	1	24	31	1.8
14	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	11	12	0.7
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	5	0.3
16	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	0.1
17	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	2	4	0.2
18	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	16	17	1.0
19	-	-	-	-	1	-	-	-	-	-	-	-	2	-	-	13	16	0.9
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	49	55	36	2	1	-	1	2	12	32	44	8	35	25	43	1382	1727	
%	2.8	3.2	2.1	0.1	0.1	-	0.1	0.1	0.7	1.9	2.5	0.5	2.0	1.4	2.5	80.0	100	
%	31.0	34.8	22.8	1.3	0.6	-	0.6	1.3	7.6	17.1	23.5	4.3	18.7	13.4	23.0			

SUMMARY ANALYSIS

	NO	%
FUNCTIONAL	1382	80.0
RELATED FAILURE	158	9.1
UNRELATED FAILURE	187	10.8
TOTAL	1727	100.0

Table 7

LIFE TABLE AND SURVIVAL ANALYSIS - ALL AMALGAM ALLOYS

75% Survival = 9.16 YEARS
50% Survival = 16.77 YEARS

YEARLY INTERVAL	*NO. ENTERED*	*NO. LOST*	*NO. FAILED*	*NO. EXPOSED*	*PROPORTION FAILED*	*PROPORTION SURVIVING*	*CUMULATIVE SURVIVAL FUNCTION*	*HAZARD FUNCTION*	*FAILURE DENSITY FUNCTION*
0-1	1,727	240	31	1,607.0	0.0193	0.9807	1.0000	0.0195	0.0193
1-2	1,456	103	51	1,404.5	0.0363	0.9637	0.9807	0.0370	0.0356
2-3	1,302	87	66	1,258.5	0.0524	0.9476	0.9451	0.0539	0.0496
3-4	1,149	136	41	1,081.0	0.0379	0.9621	0.8955	0.0387	0.0340
4-5	972	232	52	856.0	0.0607	0.9393	0.8616	0.0627	0.0523
5-6	688	110	17	633.0	0.0269	0.9731	0.8092	0.0272	0.0217
6-7	561	73	17	524.5	0.0324	0.9676	0.7875	0.0329	0.0255
7-8	471	73	4	434.5	0.0092	0.9908	0.7620	0.0092	0.0070
8-9	394	91	14	348.5	0.0402	0.9598	0.7550	0.0410	0.0303
10-11	289	38	11	270.0	0.0407	0.9593	0.7246	0.0416	0.0295
11-12	240	73	11	203.5	0.0541	0.9459	0.6951	0.0556	0.0376
12-13	156	55	14	128.5	0.1089	0.8911	0.6575	0.1152	0.0716
13-14	87	24	7	75.0	0.0933	0.9067	0.5859	0.0979	0.0547
14-15	56	11	1	50.5	0.0198	0.9802	0.5312	0.0200	0.0105
15-16	44	5	0	41.5	0.0000	1.0000	0.5207	0.0000	0.0000
16-17	39	0	2	39.0	0.0513	0.9487	0.5207	0.0526	0.0267
17-18	37	2	2	36.0	0.0556	0.9444	0.4940	0.0571	0.0274
18-19	33	16	1	25.0	0.0400	0.9600	0.4665	0.0408	0.0187
19-20	16	13	3	9.5	0.3158	0.6842	0.4479	0.3750	0.1414

Finally, the summary analysis at the bottom of the page shows the total and the relative percentage of functional restorations, related failures, and unrelated failures which were observed over the 19 year period of observation.

The statistical analysis of the clinical data in these long term survival type studies by conventional statistical procedures was confounded by the fact that the combined data represents studies of mixed durations, and most importantly, the data was incomplete or "censored". By that it is meant that restorations were no longer available for observation because: the patients refused to participate; were not available for examination; failure was due to causes other than the ones under study; or, in this case, the study was terminated prematurely and the observation period was not long enough to illicit failures for all of the materials, i.e. the restorations were withdrawn in a functional state.

Accordingly, the actuarial "Life Table" (Cutler-Ederer) technique was employed to estimate the survival (time-to-failure) distribution of the restorations which were observed over varying periods of time. A major advantage of this technique is that it utilizes all the patient follow-up information (although unequal) in estimating the survival probabilities. The life table is a method of summarizing the results of a study by grouping the times to failure into intervals. For each time interval the table records the number of restorations which are still in the study at the start of the interval, the number which failed during the interval, and the number lost or censored (lost to follow-up or withdrawn). From these numbers the probability of failure in the interval may be estimated.

The first column in Table 7 is representative of the yearly interval. The second column is the total number of restorations which entered the interval. The third column reflects the number censored or lost to further follow-up, although functional at that interval. The fourth column, as its name implies shows the total number of restorations which failed during the interval. The fifth column is a calculated value which reflects the number of restorations exposed to risk, i.e. the number entering minus one-half the censored restorations. The sixth Proportion Failed column is based upon the number of restorations exposed to risk and reflects the proportion of failed restorations or the conditional probability of failure in that particular interval. The seventh Proportion Surviving column, is calculated by subtracting the proportion failed from 1.0 and is the conditional probability of surviving in that interval. The eighth column, Cumulative Survival Function is the estimate of the cumulative proportion of restorations, surviving to the beginning of the designated interval and is calculated by multiplying the previous period's Cumulative Survival Function by the Proportion Surviving. The Hazard Function is the instantaneous failure rate and is estimated at the midpoint of the time interval. Finally, the Failure Density Function is the probability of failure per unit time at the midpoint of the time interval.

The Cumulative Survival Function is utilized to calculate the estimated times at which 50% (median survival) or 75% of the restorations will still be functional. On this basis, it is estimated that at 9.16 years, 75% of all the amalgam alloys will remain functional, and 16.77 years is the half-life of the studied amalgam alloy population.

4. RATIONALE FOR THE EVALUATION OF PERFORMANCE OF ALL RESTORATIVE MATERIALS

Previous studies of the short term clinical performance of restorative materials have focused upon a comparison of proprietary dental products by an evaluation of clinical parameters, such as color, marginal deterioration, wear, leakage, caries, etc. The limitations of these types of studies are:

1. They characterize only the specific proprietary products tested.
2. As proprietary products are changed or withdrawn, the results of the study are short lived.
3. Although the selected parameters may show statistical differences between the designated materials, there is no evidence that the parameters are predictive of the materials' ultimate long term longevity.
4. They provide no information as to the modes of failure and rationale for improvements in future classes of materials.

Since the clinical data base which we collected for the past 19 years has a broad range of proprietary materials, it was decided to pool the data and utilize the Life Table analytical procedure, to characterize *classes of restorative materials* by their survival functions and their primary modes of failure. This technique has enabled us to determine: the comparative longevity of anterior and posterior composites; whether posterior composites compared favorably with dental amalgams; if there was a difference between Class I and Class II restorations; whether the current change from low copper amalgam alloys to high copper amalgam alloys resulted in a change in longevity; if polishing an amalgam restoration increased its longevity, etc. Finally, the observed modes of failure, can serve as a rational basis for the modification of the formulation to improve specific mechanical and physical properties, or clinical operational procedures to enhance the longevity of dental restorative materials.

An exhaustive statistical analysis of the various categories of restorative materials was performed. This analysis involved the calculation of the distribution of the reasons for failure and Life Table survival analysis for each category of material. The specifics may be found in Appendix 1. The information in Table 8, is a summary of this Appendix and shows the number of restorations, the maximum age, and the survival functions of these categories of the evaluated restorative materials. As shown, the maximum age of each category ranged from 12 to 19 years. Therefore, when the 50% and 75% survival functions were calculated, these maximum periods were boundary conditions and certain of the survival functions produced longevity values somewhere in excess of the limited period of observation.

Examination of this table also revealed that causative factors which were deemed to be unrelated to the restorative material (Unrelated Failures), accounted for a mean of 10.68 percent of all the restoration placed. The percentage distribution of the reasons for Related Failure of the various categories of restorative materials is summarized in Table 9.

Table 8

DISTRIBUTION OF SURVIVAL FUNCTIONS - ALL RESTORATIVE MATERIALS

RESTORATIVE MATERIALS	*NUMBER OF REST.*	*AGE (YRS)*	*PERCENT FUNCTIONAL*	*PERCENT RELATED FAILURES*	*PERCENT UNRELATED FAILURES*	*50% SURVIVAL (YRS)*	*75% SURVIVAL (YRS)*
COMPOSITE RESINS----------	1,569	18	66.9	23.1	10.0	10.19	5.09
ANTERIOR COMPOSITES--	851	15	72.2	20.4	7.4	13.49	5.47
POSTERIOR COMPOSITES-	718	18	60.7	26.2	13.1	8.60	4.64
CLASS I--	332	18	70.5	16.9	12.6	12.12	5.36
CLASS II-	386	18	52.3	34.2	13.5	7.14	4.23
AMALGAM ALLOYS------------	1,727	19	80.0	9.1	10.9	16.77	9.16
CLASS I--	729	19	87.8	5.1	7.1	>19.00	12.64
CLASS II-	998	19	74.3	12.1	13.6	13.00	6.31
HI-CU ALLOYS---------	1366	19	81.2	8.3	10.5	13.93	9.20
LO-CU ALLOYS---------	403	19	76.2	12.2	11.7	17.47	7.90
POLISHED AMALGAMS----	975	19	76.4	10.8	12.8	16.39	6.75
POLISHED HI-CU---	667	19	78.0	9.3	12.7	13.81	6.61
CLASS I--	247	19	86.6	4.5	8.9	14.53	13.09
CLASS II-	420	19	72.9	12.1	15.0	12.97	5.79
POLISHED LO-CU---	350	19	74.0	13.4	12.6	17.09	7.30
CLASS I--	164	19	79.3	10.4	10.3	>19.00	10.60
CLASS II-	186	19	69.4	16.1	14.5	13.50	5.48
UNPOLISHED AMALGAMS--	649	12	84.9	6.8	8.3	>12.00	9.90
UNPOLISHED HI-CU-	544	12	85.1	6.8	8.1	>12.00	9.87
CLASS I--	241	12	94.2	2.1	3.7	>12.00	>12.00
CLASS II-	303	12	77.9	10.6	11.5	>12.00	7.86
UNPOLISHED LO-CU-	53	12	90.6	3.8	5.6	>12.00	12.09
CLASS I--	16	12	100.0	0.0	0.0	>12.00	>12.00
CLASS II-	37	12	86.5	5.4	8.1	>12.00	10.47
BASE METAL ALLOYS---------	365	12	80.0	9.9	10.1	>12.00	11.15
GOLD ALLOYS---------------	104	12	75.0	10.6	14.4	12.79	11.09

Table 9

DISTRIBUTION OF REASONS FOR FAILURE - ALL RESTORATIVE MATERIALS

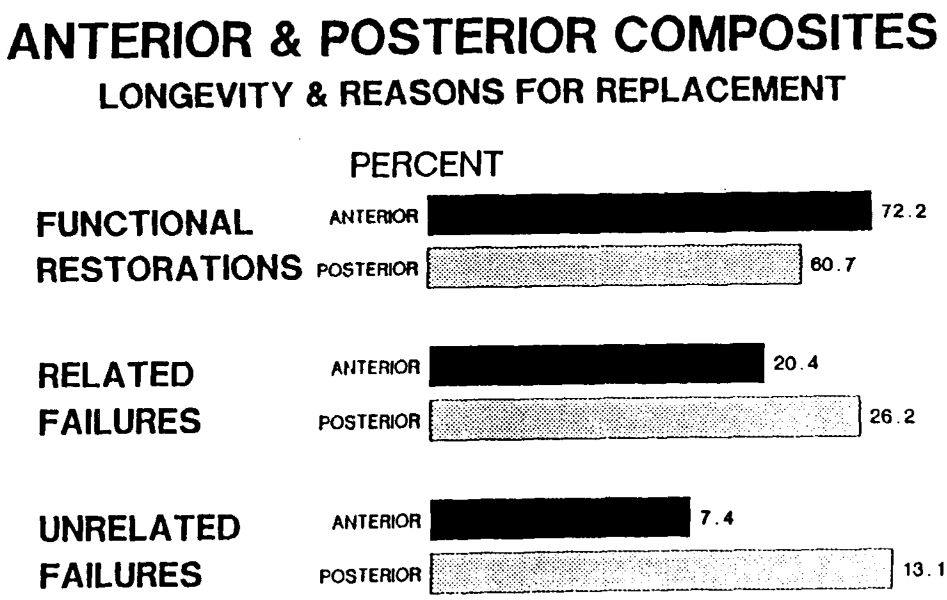
RESTORATIVE MATERIALS	*COMPOSITION*	*FINISH OR LOCATION*	*TYPE*	*PERCENT CARIES (J)*	*PERENT FRACTURE (K)*	*PERCENT MARGINS (L)*	*PERCENT OTHER (S)*	*PERCENT LEAKAGE (M)*	*PERCENT WEAR (N)*
COMPOSITE RESINS				36.7	13.3	7.7	25.5	8.0	8.8
		ANTERIOR		33.3	13.2	4.6	40.8	6.9	1.1
		POSTERIOR		39.9	13.3	10.6	10.1	9.0	16.0
			CLASS I	39.3	3.6	16.1	10.8	17.9	12.5
			CLASS II	40.2	17.4	8.3	11.4	5.3	17.4
AMALGAM ALLOYS				31.0	34.8	22.8	11.4		
	HIGH COPPER			34.5	44.2	9.7	11.6		
		POLISHED		30.6	45.2	12.9	11.3		
			CLASS I	54.5	27.3	9.1	9.1		
			CLASS II	25.5	49.0	13.7	11.8		
		UNPOLISHED		45.9	35.1	8.1	10.9		
			CLASS I	60.0	20.0	20.0	0.0		
			CLASS II	43.8	37.5	6.3	12.4		
	LOW COPPER			28.6	10.2	51.0	10.2		
		POLISHED		29.8	8.5	51.1	10.6		
			CLASS I	35.3	5.9	41.2	17.6		
			CLASS II	35.3	5.9	41.2	17.6		
		UNPOLISHED		0.0	50.0	50.0	0.0		
			CLASS I	0.0	0.0	0.0	0.0		
			CLASS II	0.0	50.0	50.0	0.0		

RESTORATIVE MATERIALS				*PERCENT CARIES (J)*	*PERCENT VENEER FAILURE (K)*	*PERCENT RETENTION FAILURE (M)*	*PERCENT OTHER (R)*
BASE METAL ALLOYS				47.2	25.0	16.7	11.1
GOLD ALLOYS				54.5	0.0	45.5	0.0

5. LONGEVITY OF ANTERIOR AND POSTERIOR COMPOSITE RESIN RESTORATIONS

A total of 23 composite resin materials, of which 10 were used for anterior restorations and 13 were used for posterior restorations, were evaluated over an 18 year period. As illustrated in Figure 1, 26.2 percent of the posterior composite restorations failed due to related reasons, as compared to only 20.4 percent for anterior composites. Similarly, the percentage of posterior restorations which failed due to unrelated reasons was also almost twice as large than that experienced with anterior composite restorations.

Figure 1



Examination of the distribution of related failures in Figure 2, shows quite vividly that Caries, is the prime mode of failure for both anterior and posterior composite restorations, i.e. 33.3 - 39.9 percent. As might be expected Wear was a significant failure factor for posterior composites and accounted for only 1.1 percent in anterior restorations. The incidence of Fracture was very similar for both types of restorations (13.2 -13.3%). Poor Margins were more prevalent in posterior composites.

As shown by the divergent plots of the Survival Functions of anterior and posterior composites in Figure 3, location of the composite restorations plays a very significant role in determining this material's ultimate longevity. The 50 percent survival times for posterior composites was only 8.60 years, as compared to 13.49 years for composites placed in the anterior region of the oral cavity. Therefore, in any study of the longevity of composite resins restorations, the relative ratio of the number of anterior and posterior restorations plays a significant role in determining ultimate failure rate.

ANTERIOR & POSTERIOR COMPOSITES
DISTRIBUTION OF RELATED FAILURES

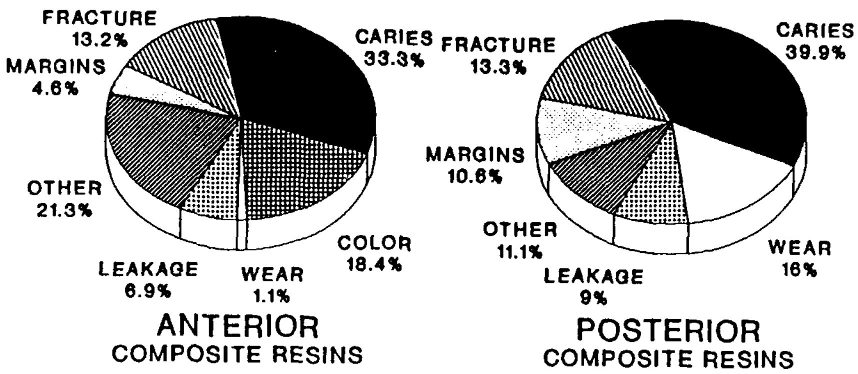


Figure 2

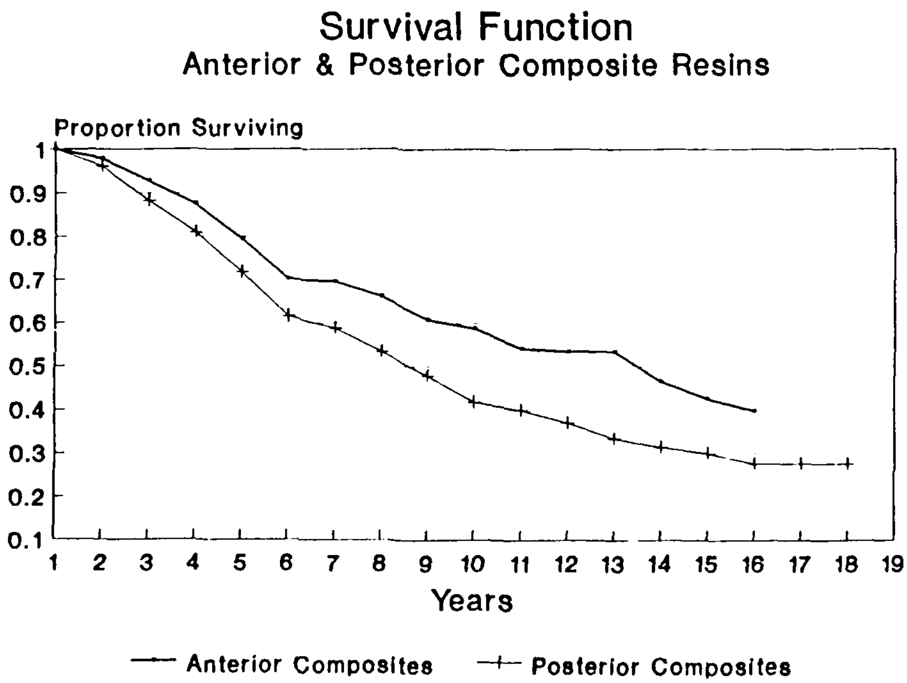
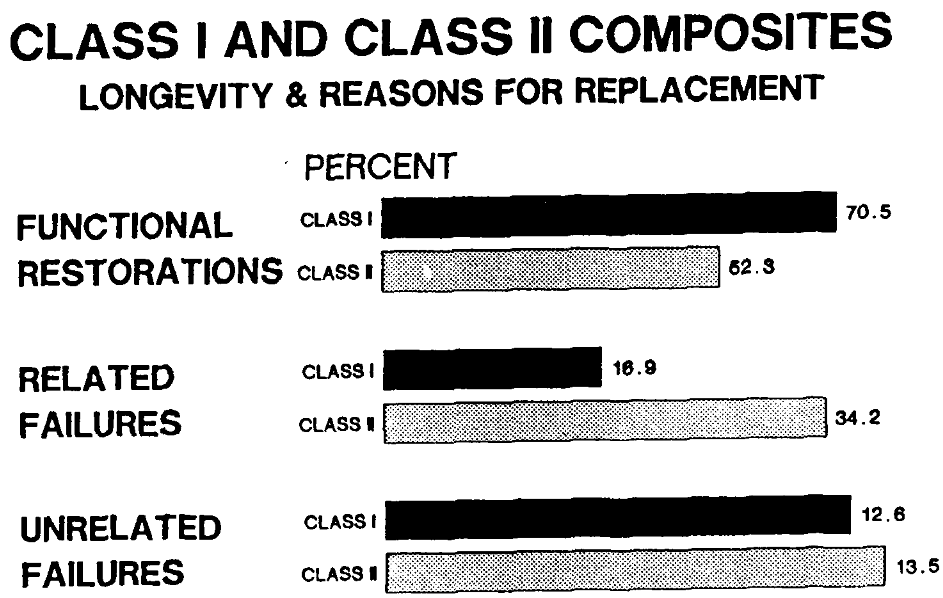


Figure 3

6. LONGEVITY OF CLASS I AND CLASS II COMPOSITE RESIN RESTORATIONS

We have shown that the longevity of posterior composite restorations was significantly less than that of anterior restorations. The question which we also addressed was whether there was a difference between Class I and Class II posterior restorations. Over an 18 year period we were able to follow a total of 13 different composite resin materials, of which there were 332 Class I restorations and a similar number of 386 Class II restorations. Figure 4 summarizes the related and unrelated reasons for replacement.

Figure 4



As can be seen, the percentage of unrelated failures for the Class I and Class II restorations was very similar, i.e. 12.6 and 13.5 percent, respectfully. However, the number of failures which were attributable to the restorative material, related failures, was more than twice as high for the Class II restorations, than the Class I restorations, i.e. 34.2 versus 16.9 percent.

Examination of the distribution of the related failures in Figure 5, shows once again, that Caries is still the prime mode of failure for both classes of restorations, i.e. approximately 40 percent. Fracture and Wear also play predominant roles in the failure pattern of Class II restorations, each of which accounted for 17.4 percent of related failures. In contrast, Fracture in Class I restorations, only account for 3.72 percent of failures. Poor Margins and Leakage appear to be the factors which each contribute between 16.1 - 17.9 percent of the related failures in Class I composite restorations.

COMPOSITE RESINS
DISTRIBUTION OF RELATED FAILURES

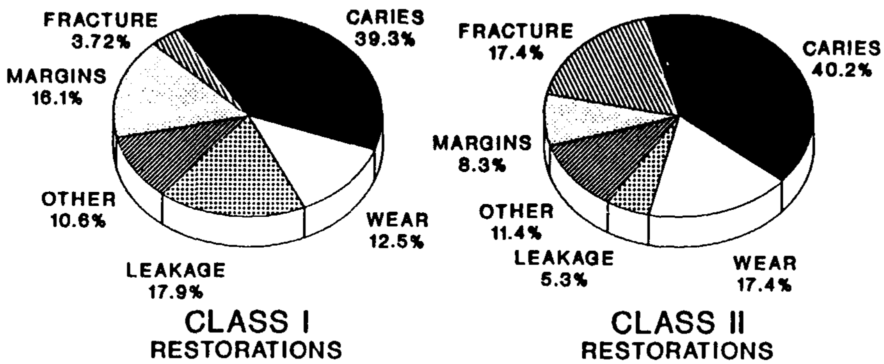


Figure 5

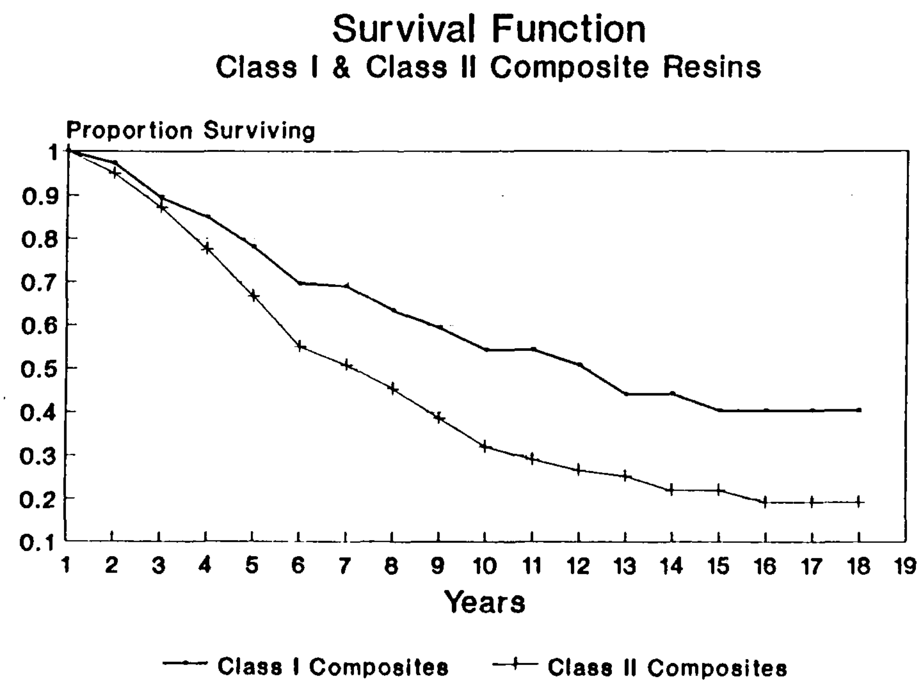


Figure 6

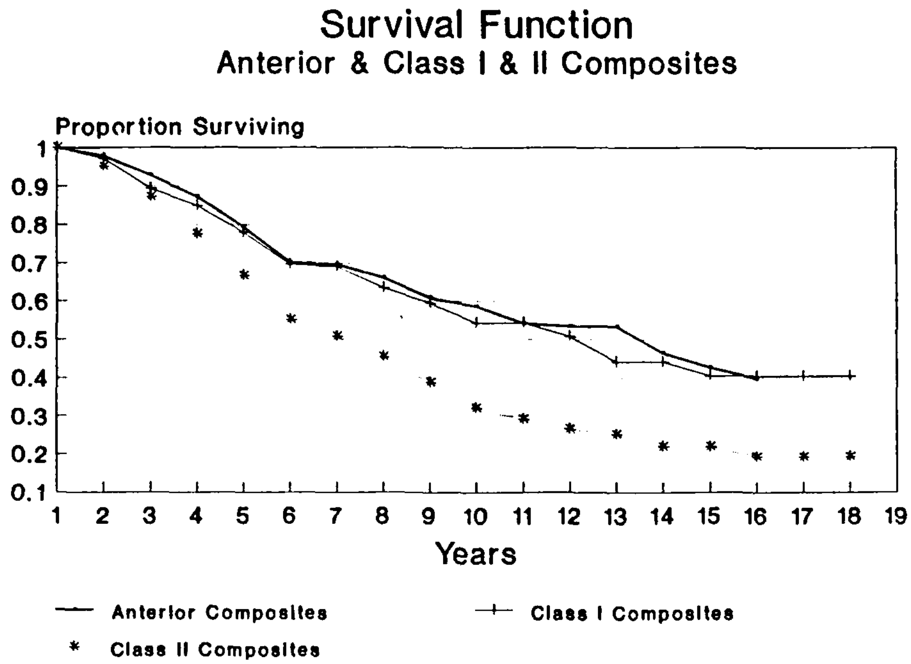


Figure 7

Examination of the plot of the survival functions of the Class I and Class II composite restorations in Figure 6, shows a conspicuous progressive divergence, which indicates a very significant enhancement of the longevity of Class I composite restorations, as compared to the Class II restorations. The 50 percent survival time for Class I composite restorations was 12.12 years, as compared to only 7.14 years for the Class II restorations.

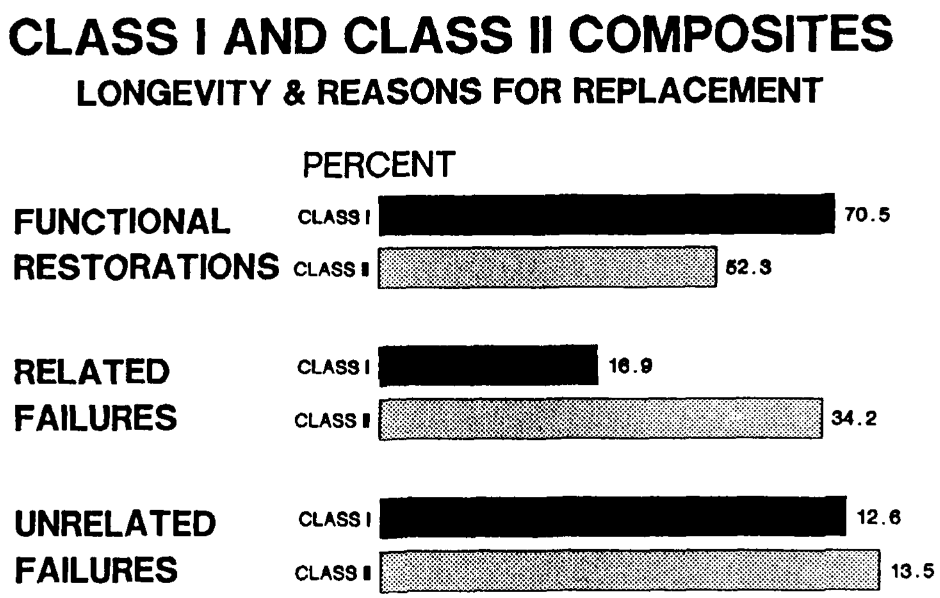
When the survival function of anterior composite restorations is plotted on the same graph as the Class I and Class II restorations in Figure 7, it is self-evident that there was no difference between the survival of anterior and Class I composite restorations. The survival of Class II composites was inferior to the other two classes of restorations.

Although considerable attention has been focused upon the wear characteristics of composites, there are a number of factors working in concert which contribute to the higher failure rate of Class II composites. The wear of composite restorations progressively decreases the amount of occlusal enamel available for bonding and progressively exposes a new generation of voids below the surface making the restoration susceptible to caries, which accounted for 40.2 percent of failures. Wear further decreases the bulk and strength of the restoration to resist flexural occlusal stresses and acts as a secondary cause for fracture. Wear together with fracture accounted for 34.8 percent of the reasons for replacement of composite resins. Therefore, Caries, Fracture and Wear account for 75 percent of the related reasons for failure of Class II restorations. In view of the foregoing, the relative ratios of the number of Class I and II restorations in posterior clinical studies can play a very significant role in the reported clinical performance of posterior composites.

7. LONGEVITY OF CLASS I AND CLASS II AMALGAM ALLOYS

Over a 19 year period, we have been able to follow the clinical performance of 31 different amalgam alloy studies involving 729 Class I and 998 Class II restorations. Figure 8 summarizes the longevity and reasons for replacement of these Class I and Class II amalgam alloy restorations. It is readily apparent that the percentage of related and unrelated failures for Class II amalgams was approximately twice as high as the similar failures experienced with the Class I type of restorations.

Figure 8



Examination of the distribution of the related failures of Class I and Class II restorations in Figure 9 shows that for both classes of materials, the combination of Caries and Fracture accounted for 67 percent of the related causes for failure. In the case of the Class II restorations, Fracture played the predominant role (39.7 percent) and for the Class I restorations, Caries was the prime cause of failure, i.e. 43.2 percent. The percentage of related failures attributable to Margins and Other causes was very similar for both classes of dental amalgam alloys.

The plot of the survival function of Class I and II restorations in Figure 10 showed a significant divergence which indicates the superior survival potential of Class I amalgam alloys. The median survival (50 percent) time for Class II restorations was 13.00 years. However, since the study was terminated at 19 years, we can only state that the median survival time for Class I restorations was somewhere in excess of 19 years. The survival potentials of the Class I and II's, in this amalgam alloy population were remarkably high.

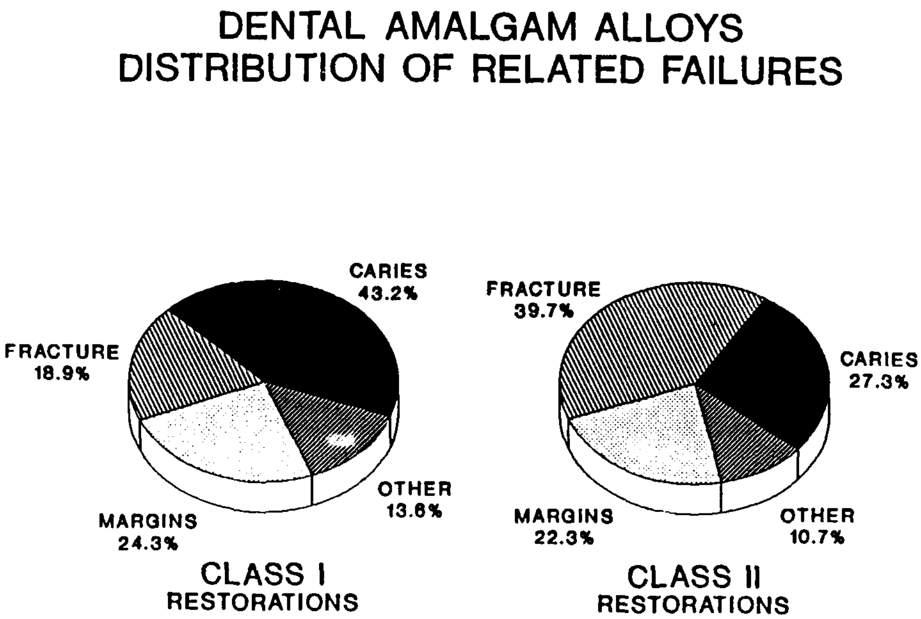


Figure 9

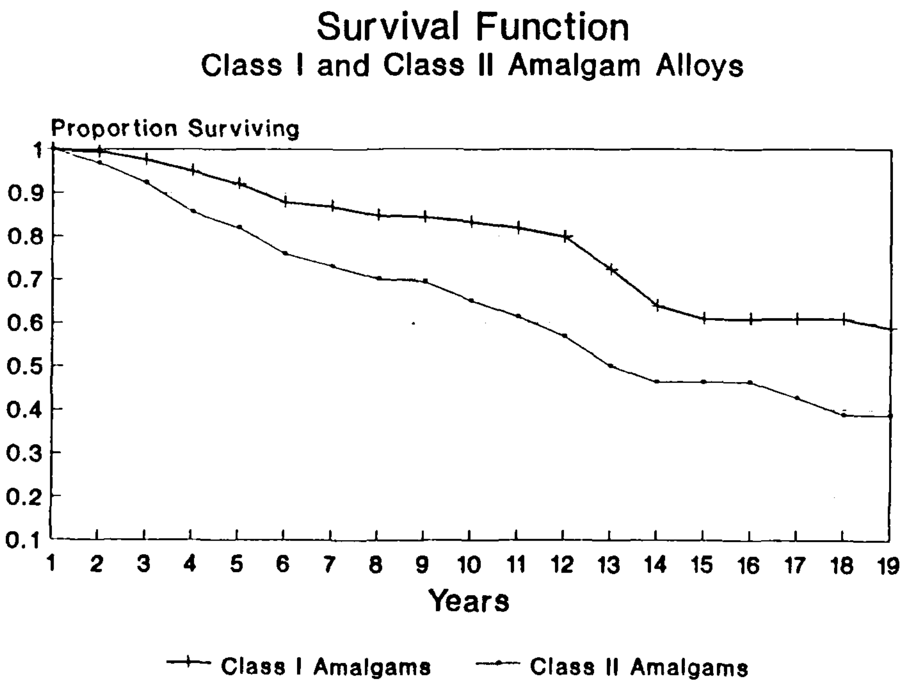
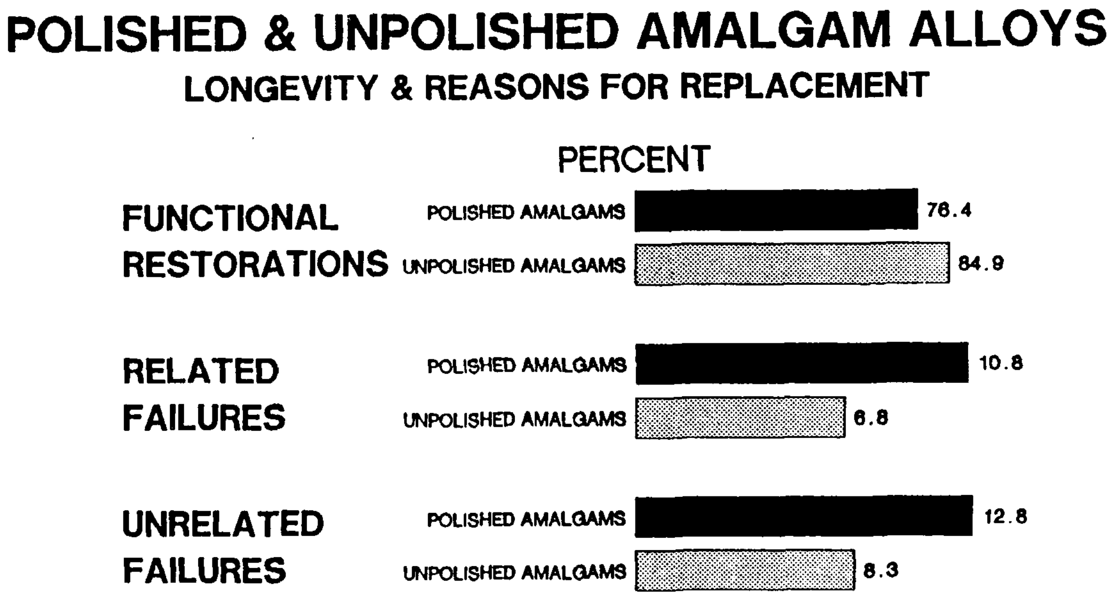


Figure 10

8. LONGEVITY OF POLISHED AND UNPOLISHED AMALGAM ALLOYS

We have controlled clinical data on 16 amalgam studies involving 975 restorations which were polished after 24 hours of insertion and were followed for a period of 19 years. Similarly, we also have information on 13 amalgam studies in which 649 amalgam restorations were left unpolished and examined for a period of 12 years. Figure 11 illustrates the distribution of the longevity and reasons for replacement of these polished and unpolished amalgam restorations.

Figure 11



A comparison of the distribution of the percent of related failures for polished and unpolished amalgam alloys may be found in Figure 12. We found that for the polished restorations Caries and Fracture accounted for 58.1 percent of the reasons for related failure, while for the unpolished restorations these two factors accounted for 81.8 percent of the failures. Inadequate Margins accounted for 30.5 percent of failures for the polished restorations and only 9.1 percent for the unpolished alloy restorations.

Examination of the plots of the survival functions in Figure 13, revealed that for the first 9 years the unpolished alloys had a higher survival potential, as evidenced by the fact that the 75% survival time was 9.9 years for the unpolished alloys as compared to only 6.75 years for the polished alloys. However, at the end of 13 years 57.4 percent of the polished restorations were functional, versus 58.5 percent, for the unpolished amalgam alloys. Polishing amalgam alloy restorations does not appear to increase the restoration's longevity and the increased time and expense of this procedure is not warranted.

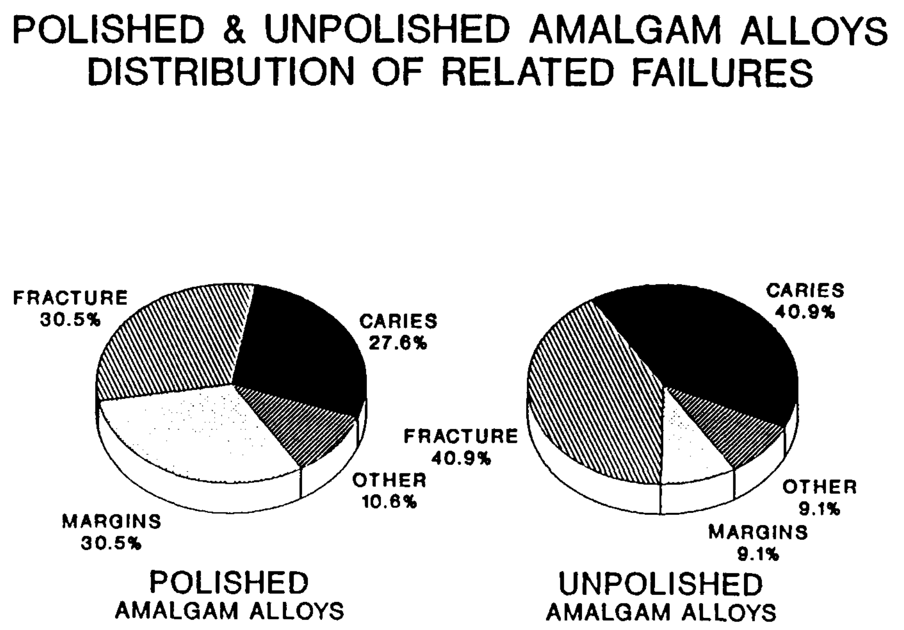


Figure 12

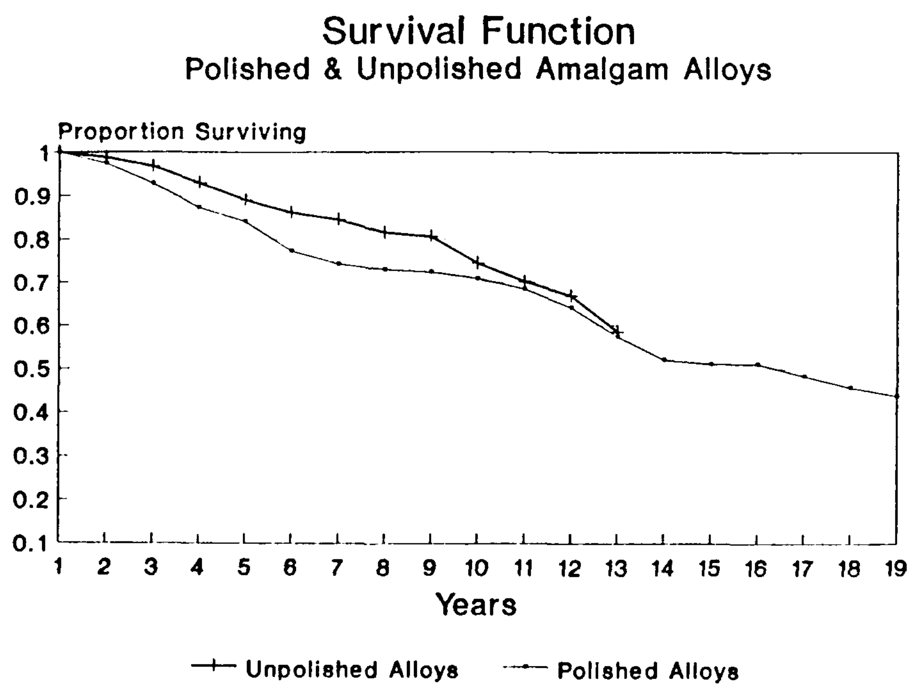
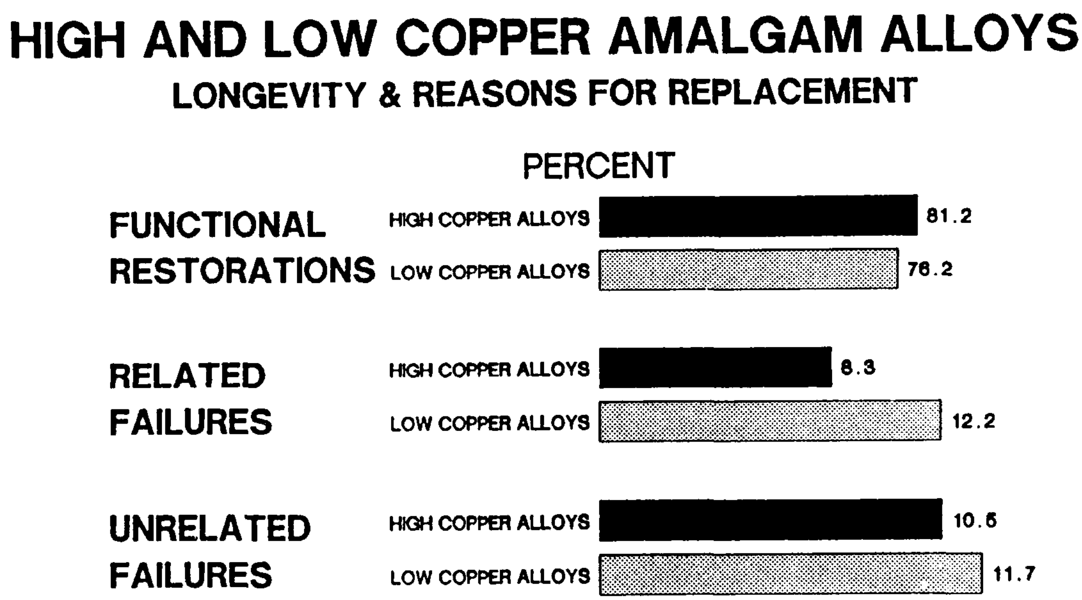


Figure 13

9. LONGEVITY OF HIGH AND LOW COPPER AMALGAM ALLOYS

Considerable interest has been focused lately on the superior short term clinical performance of High Copper amalgam alloys. Over the past 19 years, we have clinical information on 26 amalgam studies which utilized High Copper amalgam alloys and involved 1,366 restorations. We also have clinical data on 7 amalgam studies which utilized Low Copper amalgam alloys and involved 403 restorations. Figure 14 summarizes the percentage of related and unrelated reasons for replacement of these two types of amalgam alloy restorations.

Figure 14



The percentage of unrelated reasons for failure of High and Low copper amalgam alloys was very similar, i.e. 10.5 vs. 11.7 percent, respectively. However over the 19 year period of observation it appeared that the incidence of related reasons of failure was higher for the Low Copper alloys than the High Copper alloys, i.e. 12.2 vs. 8.3 percent, respectively.

Examination of the distribution of these related reasons for failure in Figure 15 revealed some startling difference between these two amalgam alloy formulations. The superior short term performance of the margins of High Copper amalgam alloys appears to be reflected in a long term low incidence of marginal failure (9.7 percent of related failures). In contrast, the percentage of related failures of margins for the Low Copper amalgam formulations was 51 percent.

HIGH & LOW COPPER AMALGAM ALLOYS
DISTRIBUTION OF RELATED FAILURES

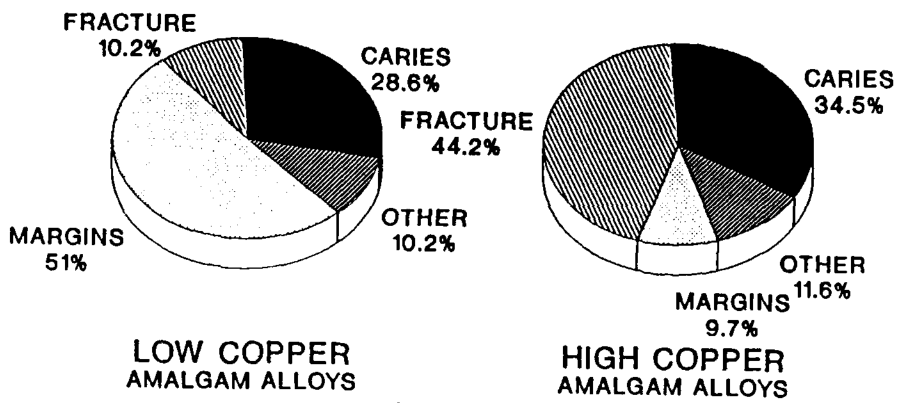


Figure 15

Survival Function
High & Low Copper Amalgam Alloys

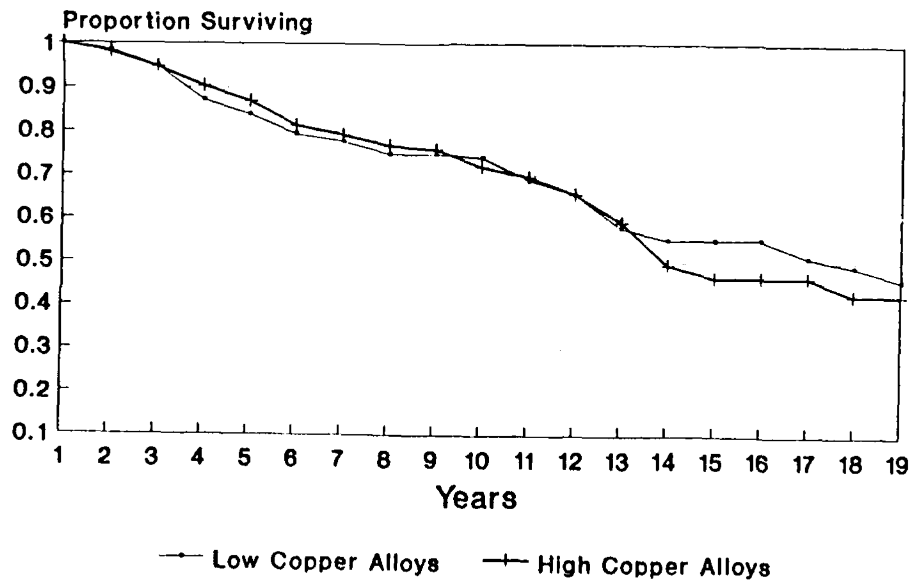


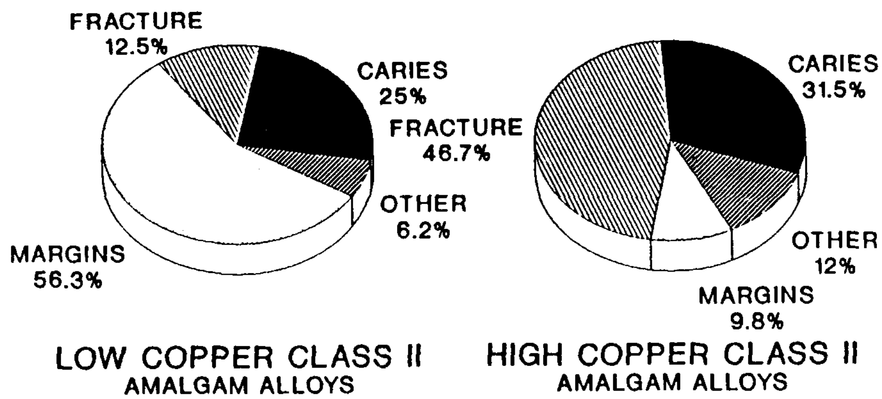
Figure 16

Although the percentage of marginal failures was relatively low for the High Copper alloys, the percentage of related failures caused by fracture was very high as compared to that experienced with the Low Copper amalgam alloys, i.e. 44.2 vs. 10.2 percent. The incidence of other related causes for failure was very similar for both amalgam alloy formulations, i.e. 10.2 - 11.6 percent.

Recognizing that the preceding High and Low Copper survival data was pooled from both Class I and Class II restorations, we elected to examine the distribution of related failures in the more exacting Class II applications (Figure 17). Of the previously reported High Copper alloys, 54.5 percent were Class II's amd 55.3 percent of the Low Copper alloys were Calss II's. Examination of Class II restorations showed a very similar distribution to the data in the previous graph in Figure 15.

Figure 17

HIGH & LOW COPPER CLASS II AMALG. ALLOYS
DISTRIBUTION OF RELATED FAILURES

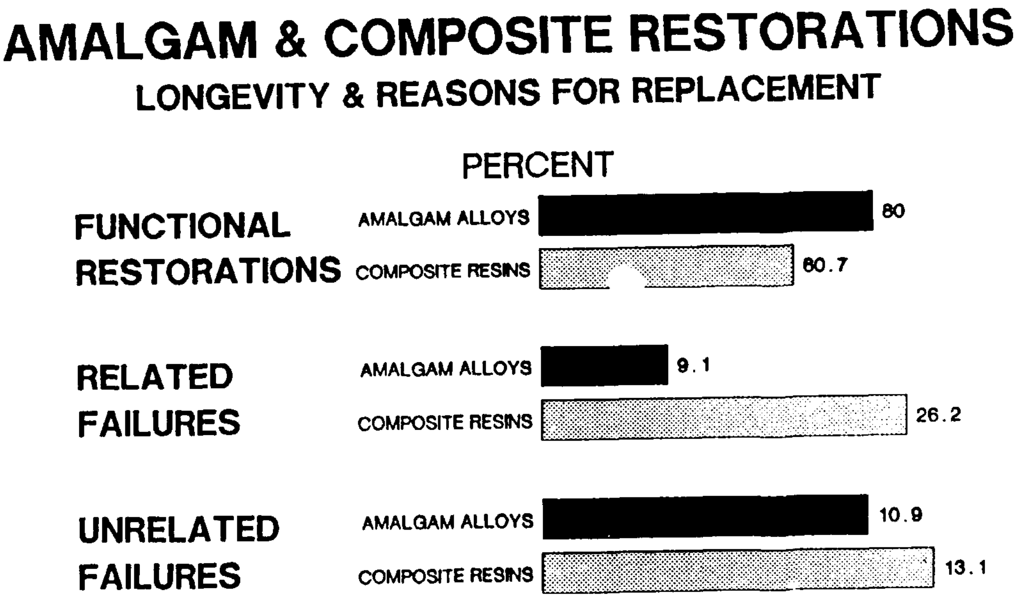


Examination of plots of the survival functions of High and Low Copper amalgam alloys in Figure 16, shows that for the first 13 years, there appears to be little difference in the survival potential of these two different composition amalgam alloys. However, for those restorations which survived beyond this period, the Low Copper amalgam alloys had a higher survival rate. The mean survival time (50% survival) for the Low and High Copper amalgam alloys which comprised this population was 17.47 vs. 13.93 years, respectively. Although High Copper amalgam alloys have improved margins, the increased incidence of gross fracture results in an ultimate longevity which is not different from the previously used Low Copper amalgam alloys.

10. LONGEVITY OF AMALGAM ALLOYS AND POSTERIOR COMPOSITE RESINS

Recent interest has focused upon the replacement of amalgam alloys with composite resins for the esthetic restoration of posterior teeth. To compare the longevity of these two types of restorative materials we analyzed 31 different amalgam studies, which involved 1,727 restorations, and 13 posterior composite resins studies, which involved 718 restorations. A summary of the longevity and reasons for replacement of these two types of restorative materials may be found in Figure 18.

Figure 18



Examination of the information contained within Figure 18 illustrates that between 10.9 and 13.1 percent of the amalgam alloy and composite resin restorations were replaced due to reasons which were not related to either of the two restorative materials. However, use of composite resins in posterior teeth resulted in material related failures which was approximately three times that experienced with dental amalgam alloys, 26.2 vs. 9.1 percent.

The distribution of the relative percentages of these related failures is shown in Figure 19. These charts summarize a combination of Class I and II restorations for both materials. Although Fracture (34.8 percent) was one of the two principal causes of failure (along with Caries) for amalgam alloys, it only accounted for 13.3 percent of failures of composite resins. Similarly, the percentage of related failures attributable to inadequate margins for composite resins was 10.6 percent as compared to 22.8 percent for amalgam alloys. However, excessive Wear (16.0 percent) and marginal Leakage (9.0 percent) in composite resins were not observed in amalgam alloy restorations.

AMALGAM ALLOYS & POSTERIOR COMPOSITES DISTRIBUTION OF RELATED FAILURES

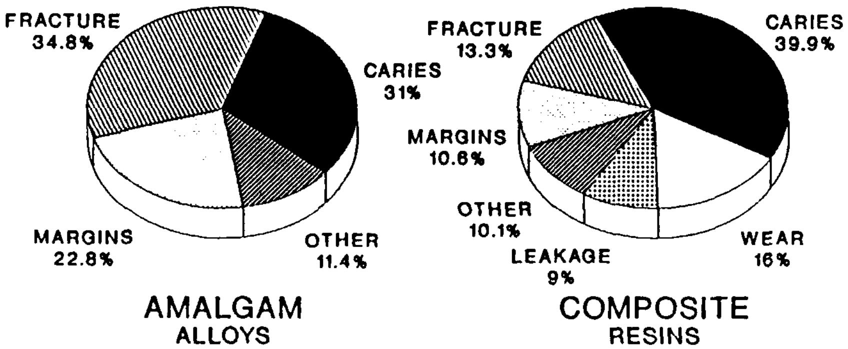


Figure 19

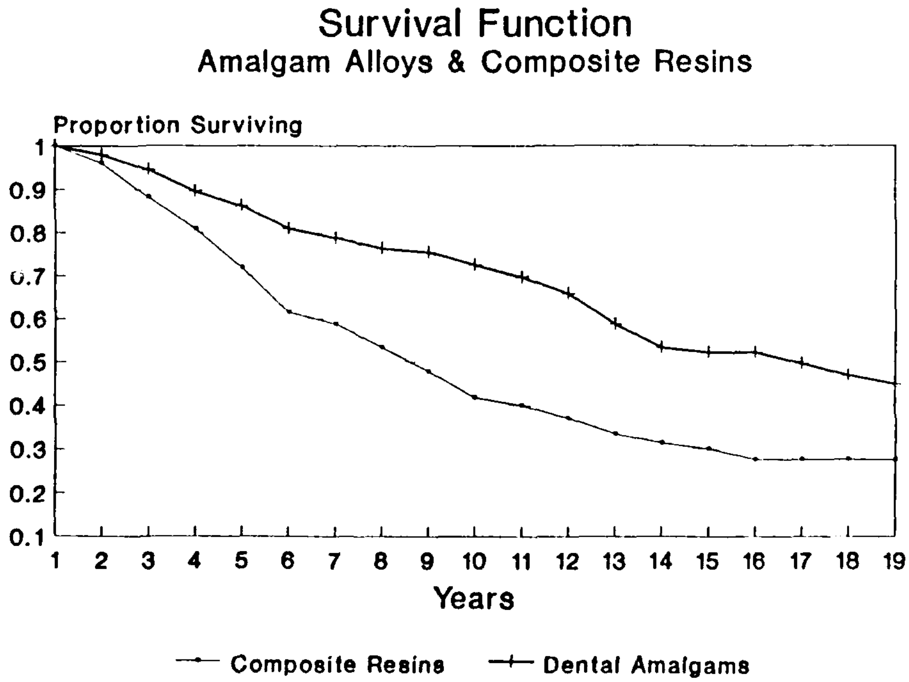


Figure 20

The plots of the survival functions of the amalgam alloys and composite resins in Figure 20 show a very significant divergence. The mean survival time (50 percent survival) for the surveyed amalgam alloys was 16.77 years as compared to 8.60 years for the composite resins. Similarly, at the 75 percent interval, the survival time for the composite resins was approximately one-half that of the amalgam alloys, i.e. 4.64 vs. 9.16 years. Therefore, the election to utilize an esthetic composite resin for the restoration of posterior teeth will result in an approximate 50 percent reduction in the longevity of these restorations.

In spite of acid etching and placement under a rubber dam, the proximal gingival area of Class II restorations is an area of high suspicion. Although the composites were injected into place, the inability to pack the material, as we do amalgam, may be responsible for inadvertent voids in difficult access areas. It is also possible that the relatively small amount of gingival enamel available for etching and bonding may be a contributing factor. The incorporation of voids during mixing is an inescapable occurrence. This problem may be minimized by the newer single component visible light activated resin systems. In any event, when defects occur on the margins, they aggravate the potential for leakage and caries.

Although considerable attention has been focused upon the wear characteristics of composites, excessive wear ranked second as the "primary" reason for replacement of restorations. The relatively high incidence of caries associated with posterior composites is a matter of serious concern. It was not uncommon for us to examine the margins of a composite restoration with a sharp explorer and find only one area of penetration in an otherwise perfect restoration. Our experience has led us to be highly suspicious of what might appear, in the case of an amalgam restoration, to be a trivial defect. Excavation of the composite in these instances, usually revealed an underlying carious lesion. Unlike dental amalgam in which corrosion products act to seal small marginal defects, composite restorations lack this ability. We have learned that voids and other marginal defects in composite resins must be considered highly suspect.

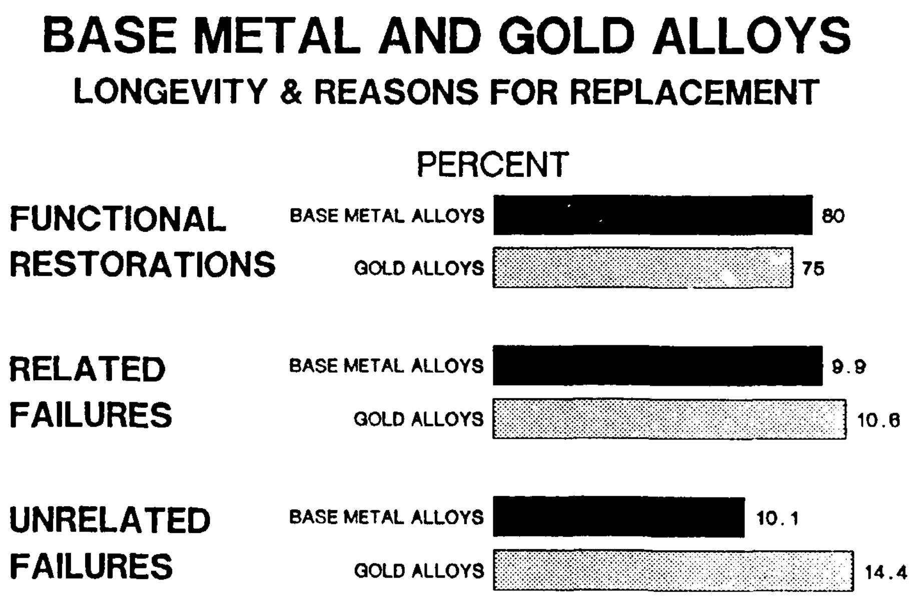
There is no doubt that wear of composite restorations progressively decreases the amount of occlusal enamel available for bonding and progressively exposes a new generation of voids below the surface that make the restoration susceptible to caries, accounting for 39.9 percent of failures. Wear further decreases the bulk and strength of the restoration to resist flexural occlusal stresses and acts as a secondary cause for fracture, which accounts for 13.3 percent of the reasons for replacement of composite resins.

On the basis of our controlled clinical studies of the comparative longevity of composite and amalgam restorations, it would appear that there is a significant decrease in the longevity of composite resin posterior restorations. The selection of this restorative material should be based upon a patient's desire for an esthetic tooth colored restorative material, or where documented hypersensitivity to the constituents of dental amalgam precludes its use. However, in both instances the patient and clinician should be aware of the need for close yearly re-examination, and the high probability that these composite restorations will not last as long as dental amalgams.

11. LONGEVITY OF BASE METAL AND GOLD ALLOYS

The introduction of base metal alloys for use in fixed prosthodontics was originally stimulated by the relatively high cost of gold alloys. Currently, we have collected clinical information on 9 different base metal alloy studies that include 365 fixed prosthodontic units and one gold alloy which involves 100 units. The information graphically depicted in Figure 21 summarizes the longevity and reasons for replacement of these two alloys intended for use in fixed prosthodontics.

Figure 21



As noted in Figure 21, over the 12 years of observation the percentage of restorations lost due to material related reasons for both the base metal and gold alloys was relatively low and similar in nature, i.e. 9.9 - 10.6 percent. Interestingly, for both fixed prosthodontic materials the perecntage of units lost for reasons which were not related to the specific materials was higher than that due to related reasons, i.e. 10.1 - 14.4 percent.

The gold alloy represented only one material which was intended for porcelain-fused-to-metal applications. For this gold alloy, recurrent Caries was the predominant reason for failure, i.e. 54.5 percent. Loss of Retention accounted for the balance of reasons for failure, i.e. 45.5 percent. For the base metal alloys, Caries was also the major reason for failure (47.2 percent). However, loss or Retention accounted for only 16.7 percent of the failures. Loss of the overlying porcelain Veneer was the predominant secondary cause of failure and was responsible for 25.0 percent of the failures.

BASE METAL & GOLD ALLOYS
DISTRIBUTION OF RELATED FAILURES

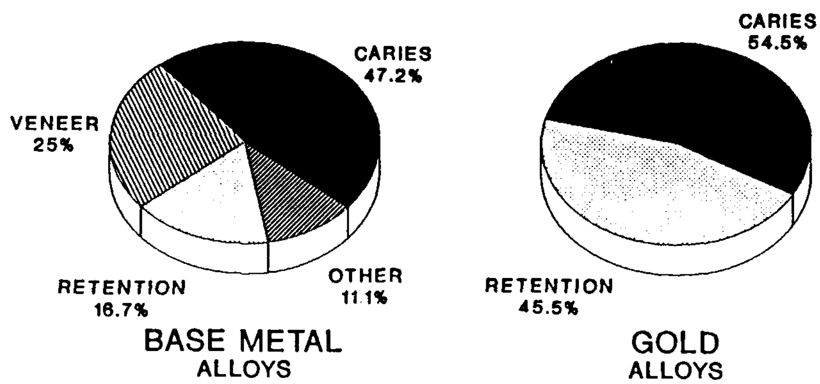


Figure 22

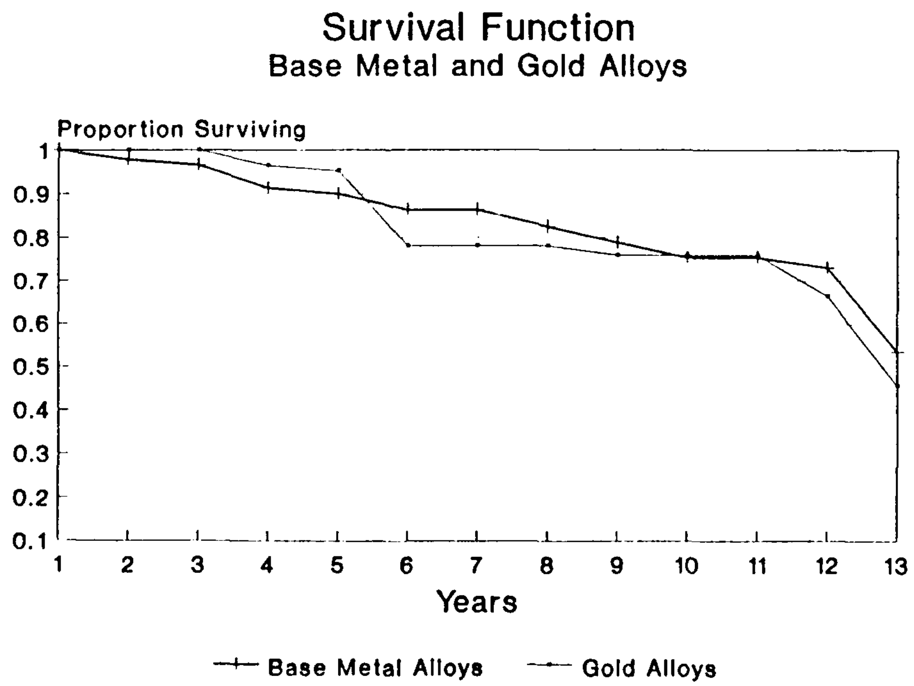


Figure 23

Examination of the plots of the survival functions of the base metal and gold alloys showed an inconsistent pattern with several reversals over the limited period of observation. The 75 percent survival time for the base metal and gold alloy was 11.15 and 11.09 years, respectively. Although there were specific differences in the reasons for replacement for the base metal and gold alloys, there was no difference in the overall longevity of these two fixed prosthodontic restorative materials. The relatively low cost base metal alloys are a viable alternative to gold alloys as a fixed prosthodontic restorative material.

12. NICKEL SENSITIVITY - DESCRIPTION OF THE RETROSPECTIVE STUDY

It has been well documented that nickel is one of the most common causes of allergic contact dermatitis, and dermatologists maintain that it produces more allergic reactions than all other metals combined. In view of the expanded dental usage of nickel containing base metal alloys, questions have been raised whether intra-oral exposure to a nickel containing alloy can result in an induced nickel sensitivity. Accordingly, a retrospective epidemiological study was conducted to determine whether there was a positive relationship between the incidence of nickel sensitivity and the presence of intra-oral nickel containing dental alloys.

Adult male and female patients requiring routine dental care at this clinical research facility were patch tested for their sensitivity to both nickel and chromium. The outer arm was selected as the test site. Nickel sulfate, 2.5% in petrolatum and potassium dichromate, 0.5% were the screening allergens used. According to standards established by the International and North American Contact Dermatitis Group, the allergens were applied and the test sites were examined independently by two examiners five days after initial placement. The reactions at the test sites were classified according to the following criteria:

1. Negative - no reaction
2. Weak Positive - papules less than 75% of the test site
3. Strong Positive - confluent papules equal to or greater than 75% of the test site.

In addition, each patient was requested to complete a health history questionnaire which included questions relating to current medication, sensitivity to any metals or jewelry, presence of pierced ears and metallic implants. Patients with dermatologic conditions and those receiving corticosteroids or any other medication which might interfere with the interpretation of the planned sensitivity patch tests were excluded from the study.

All patients were given a dental examination and the following information was collected and entered into our clinical computer system:

1. Demographic information to include the patients' age, sex, race, and occupation.
2. Classification of both fixed and removable prostheses present in the patients' oral cavity, with particular emphasis upon whether these were gold alloy, nickel-chromium, cobalt-chromium alloys and their duration.
3. Results of the patch tests and the health history questionnaire.

The hypothesis to be tested was that there would be no significant difference in the presence of nickel sensitivity between those patients who possess intra-oral nickel dental appliances and control patients with no intra-oral exposure to nickel. The hypothesis was tested by constructing contingency tables and assessing statistical significance using the Chi-square statistic. A probability of less than five percent was selected to signify statistical significance.

13. NICKEL SENSITIVITY - RELATIONSHIP TO THE USE OF BASE METAL ALLOYS

We have examined and conducted patch tests for both nickel and chromium on 442 patients. As indicated in Table 10, there were 270 males and 172 females in the examined patient population. Dental examinations revealed that between 28 - 32 percent of these patients possessed dental fixed prostheses made with confirmed nickel-chromium base-metal alloys.

Table 10

DISTRIBUTION OF PATIENTS IN NICKEL SENSITIVITY STUDY

	MALES	FEMALES	TOTAL
Total Number of Patients Examined	270	172	442
Number of Patients with Dental Base Metal Alloys	76	56	132
Percent of Patients with Dental Base Metal Alloys	28.2%	32.6%	29.9%

As shown in Table 11, we found that female patients in the 25-44 age group had a significantly higher incidence of nickel sensitivity than other age groups (significance level 2.7%). This data revealed that 9.7 percent of the 72 females in the 25-44 age group were strongly sensitive to nickel. In contrast, the incidence of nickel sensitivity in all other age groups was only 2 out of 100 individuals, or only 2.0 percent. Therefore, females within the ages of 24-44 had a sensitivity to nickel which was 4.9 times that of other age groups. In contrast, the incidence of nickel sensitivity in male patients revealed no significant difference between the various age groups. Within the 25-44 age group, approximately one percent of males were found sensitive to nickel as compared to ten percent for females.

As shown in Table 12, we found that of the 172 patients in our female population, a total of 130 or 75.6 percent of them had their ears pierced, as compared to only 6.7 percent for men. Interestingly, none of the males with pierced ears, tested positively to nickel. In contrast, 90 percent of the total number of positive reactions to nickel were found in female patients with pierced ears. Those women who reported to have suffered from skin problems associated with the wearing of jewelry, such as itching, swelling and redness, also accounted for 90 percent of the total positive reactions to nickel. Approximately one-quarter of women who experienced these jewelry related skin problems were found to be sensitive to nickel. Within the 24-44 age group, the incidence of jewelry related skin problems and nickel sensitivity increased to one-third of this age group.

In view of the very significant correlation of pierced ears with the incidence of nickel sensitivity, it was decided to stratify the analysis of female sensitivity on this basis when examining the effects of intra-oral exposure to nickel. As shown in Tables 13, we found that 2 out of 56 female patients with a history of intra-oral exposure to nickel were also sensitive to this metal, i.e. 3.6 percent. Of the female patients with pierced ears and a history of intra-oral exposure, 4.7 percent were sensitive to nickel. We found that 3.7 percent of female patients with no evidence of intra-oral exposure to nickel were also sensitive to this metal. Statistical analysis revealed that there was no significant difference between the test group, who had experienced intra-oral exposure, and the control group with no oral exposure to nickel. Similar results were obtained with the male participants in the study. However, in view of the low incidence of nickel sensitivity in males, i.e., less than 1.0%, statistical analysis was not possible with the limited sample size.

Dermatologists currently employ the dimethylglyoxime test to determine whether a suspect metal contains nickel. This test involves the use of dimethylglyoxime and ammonium hydroxide on the test metal which allegedly produces a pink discoloration as a positive indication for the presence of nickel. We found that this test is unreliable for dental alloys. This test will fail to produce a pink discoloration on dental base metal alloys, in spite of the fact that a dental alloy contains nickel and will produce a dermal reaction in a nickel sensitive individual.

This study revealed a very significant difference between male and female sensitivity to nickel. Less than one percent of males were reactive, while the overall sensitivity of females was five percent. The relative risk of female sensitivity to nickel between the ages of 24-44 was 4.8 times that of other age groups, i.e. 9.7 percent of females were sensitive to nickel as compared to 0.8 percent for males. For females there was a very positive correlation with pierced ears and jewelry related dermatologic symptoms. The overall sensitivity to chromium was 1.5 percent for males and 4.5 percent for females. There was no evidence of cross reactivity between nickel and chromium. We did not find any correlation between the dental use of nickel containing base-metal alloys and the increased incidence of nickel sensitivity.

Table 11

FEMALE'S SENSITIVITY TO NICKEL AND CHROME

AGE YRS	NO. IN GROUP N= 172	STRONGLY POSITIVE NICKEL %(NO.)	STRONGLY POSITIVE CHROMATE %(NO.)	WEAKLY POSITIVE NICKEL %(NO.)	WEAKLY POSITIVE CHROMATE %(NO.)	STRONGLY POSITIVE NICKEL & CHROMATE %(NO.)	STRONGLY POSITIVE NICKEL & WEAKLY POSITIVE CHROMATE %(NO.)	STRONGLY POSITIVE CHROMATE & WEAKLY POSITIVE NICKEL %(NO.)	WEAKLY POSITIVE NICKEL & WEAKLY POSITIVE CHROMATE %(NO.)
<=24	22	4(1)	4(1)	0(0)	9(2)	0(0)	4(1)	0(0)	0(0)
25-34	51	9(5)	9(5)	1(1)	21(11)	0(0)	3(2)	1(1)	0(0)
35-44	21	9(2)	0(0)	0(0)	23(5)	0(0)	4(1)	0(0)	0(0)
45-54	41	2(1)	0(0)	4(2)	17(7)	0(0)	2(1)	0(0)	0(0)
>=55	37	0(0)	2(1)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
TOTAL	172	5(9)	4(7)	1(3)	14(25)	0(0)	2(5)	0(1)	0(0)

Table 12

FEMALE'S SENSITIVITY TO NICKEL AND CHROME WHO HAVE PIERCED EARS

AGE YRS	NO. IN GROUP N= 130	STRONGLY POSITIVE NICKEL %(NO.)	STRONGLY POSITIVE CHROMATE %(NO.)	WEAKLY POSITIVE NICKEL %(NO.)	WEAKLY POSITIVE CHROMATE %(NO.)	STRONGLY POSITIVE NICKEL & CHROMATE %(NO.)	STRONGLY POSITIVE NICKEL & WEAKLY POSITIVE CHROMATE %(NO.)	STRONGLY POSITIVE CHROMATE & WEAKLY POSITIVE NICKEL %(NO.)	WEAKLY POSITIVE NICKEL & WEAKLY POSITIVE CHROMATE %(NO.)
<=24	21	4(1)	4(1)	0(0)	9(2)	0(0)	4(1)	0(0)	0(0)
25-34	44	11(5)	9(4)	2(1)	22(10)	0(0)	4(2)	2(1)	0(0)
35-44	20	10(2)	0(0)	0(0)	25(5)	0(0)	5(1)	0(0)	0(0)
45-54	26	0(0)	0(0)	7(2)	7(2)	0(0)	0(0)	0(0)	0(0)
>=55	19	0(0)	5(1)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
TOTAL	130	6(8)	4(6)	2(3)	14(19)	0(0)	3(4)	0(1)	0(0)

Table 13

FEMALE'S SENSITIVITY TO NICKEL AND CHROME AND ENVIRONMENTAL FACTORS

	NO. IN GROUP	STRONGLY POSITIVE NICKEL %(NO.)	STRONGLY POSITIVE CHROMATE %(NO.)	WEAKLY POSITIVE NICKEL %(NO.)	WEAKLY POSITIVE CHROMATE %(NO.)	STRONGLY POSITIVE NICKEL & CHROMATE %(NO.)	STRONGLY POSITIVE NICKEL & WEAKLY POSITIVE CHROMATE %(NO.)	STRONGLY POSITIVE CHROMATE & WEAKLY POSITIVE NICKEL %(NO.)	WEAKLY POSITIVE NICKEL & WEAKLY POSITIVE CHROMATE %(NO.)
FIXED GOLD ALLOY	50	4(2)	4(2)	4(2)	6(3)	0(0)	0(0)	2(1)	0(0)
FIXED NICKEL ALLOY	56	3(2)	3(2)	3(2)	8(5)	0(0)	3(2)	1(1)	0(0)
REMOVABLE CHROME COBALT	16	0(0)	0(0)	6(1)	12(2)	0(0)	0(0)	0(0)	0(0)
REMOVABLE NICKEL ALLOY	0	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
PIERCED EARS & FIXED GOLD ALLOY	36	5(2)	2(1)	5(2)	5(2)	0(0)	0(0)	2(1)	0(0)
PIERCED EARS & FIXED NICKEL ALLOY	43	4(2)	4(2)	4(2)	11(5)	0(0)	4(2)	2(1)	0(0)
METAL IMPLANT & FIXED GOLD ALLOY	2	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
METAL IMPLANT & FIXED NICKEL ALLOY	3	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)

Table 14

MALE'S SENSITIVITY TO NICKEL AND CHROME AND ENVIRONMENTAL FACTORS

	NO. IN GROUP	*STRONGLY POSITIVE NICKEL %(NO.)*	*STRONGLY POSITIVE CHROMATE %(NO.)*	*WEAKLY POSITIVE NICKEL %(NO.)*	*WEAKLY POSITIVE CHROMATE %(NO.)*	*STRONGLY POSITIVE NICKEL & CHROMATE %(NO.)*	*STRONGLY POSITIVE NICKEL & WEAKLY POSITIVE CHROMATE %(NO.)*	*STRONGLY POSITIVE CHROMATE & WEAKLY POSITIVE NICKEL %(NO.)*	*WEAKLY POSITIVE NICKEL & WEAKLY POSITIVE CHROMATE %(NO.)*
FIXED GOLD ALLOY	80	1(1)	2(2)	1(1)	8(7)	0(0)	0(0)	0(0)	0(0)
FIXED NICKEL ALLOY	76	2(2)	2(2)	0(0)	11(9)	0(0)	1(1)	0(0)	0(0)
REMOVABLE CHROME COBALT	47	0(0)	2(1)	2(1)	8(4)	0(0)	0(0)	0(0)	0(0)
REMOVABLE NICKEL ALLOY	1	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
PIERCED EARS & FIXED GOLD ALLOY	7	0(0)	0(0)	0(0)	14(1)	0(0)	0(0)	0(0)	0(0)
PIERCED EARS & FIXED NICKEL ALLOY	7	0(0)	0(0)	0(0)	14(1)	0(0)	0(0)	0(0)	0(0)
METAL IMPLANT & FIXED GOLD ALLOY	6	0(0)	16(1)	0(0)	16(1)	0(0)	0(0)	0(0)	0(0)
METAL IMPLANT & FIXED NICKEL ALLOY	7	0(0)	14(1)	0(0)	14(1)	0(0)	0(0)	0(0)	0(0)

14. QUANTIFICATION OF THE WEAR OF DENTAL RESTORATIONS

In view of the effects which excessive wear of composites can have upon the incidence of caries, fracture, and reduced longevity, there is an acute need to develop an accurate and precise means to quantify the occlusal wear and /or loss of dental restorative materials. During the period of support for this Interagency Agreement, we have developed an accurate measuring instrument which calibrated evaluators may utilize to visually ascertain the extent of wear or loss of dental restorative materials, in terms of standardized units.

The instrument, which we have termed the M-L Scale, is a simple micrometric scale which utilizes 18 standards, representing uniform progressive defects, ranging from 0 to 1.000mm. In use, replicated models of test dental restorations are visually compared to the scale, and a measurement based upon a true ratio scale is obtained in terms of standardized 0 to 40 scale units. The M-L Scale provides a universal base of reference which investigators can utilize to compare the clinical wear of dental restorative materials.

Each of the 18 scale standards was produced in an epoxy die material from poly-ether type impressions of the retracted spindle of a micrometer with a resolution of 0.001mm. By progressively retracting the micrometer spindle, it was possible to produce incremental defects ranging from 0 to 1.000mm. Due to the cylindrical shape of the micrometer components, the simulated defects produced are of uniform depth, and each scale standard has the same defect diameter. The impressions of these defects were utilized to produce a controlled number of M-L Scales and improved dental stone Calibration Standards.

The use of the M-L Scale is a comparative perceptual task in which the evaluator selects the scale unit which best approximates the extent of loss evidenced on the replicated test restoration. Consequently, the M-L Scale intervals are of necessity, limited to the perceptual discriminatory limitations of the observer. On the basis of experimental evidence, we determined that with defects within the range of 0 to 0.100mm, individuals were able to reliably discriminate 0.025mm. Between 0.150 to 0.450mm. the perceptual limitation was 0.050mm., and from 0.500 to 1.000mm. the sensitivity was further reduced to 0.100mm. As shown in Table 15, an 18 step scale based upon perceptual discriminatory limitations was constructed.

Table 15

DIMENSIONS OF THE M-L SCALE

Most Sensitive Color - Green		Intermediate Sensitivity Color - Yellow		Least Sensitive Color - Red	
Scale No.	*mm.*	*Scale No.*	*mm.*	*Scale No.*	*mm.*
0	0.000	6	0.150	20	0.500
1	0.025	8	0.200	24	0.600
2	0.050	10	0.250	28	0.700
3	0.075	12	0.300	32	0.800
4	0.100	14	0.350	36	0.900
		16	0.400	40	1.000
		18	0.450		

The standardized units of the M-L Scale are based upon multiples of a common and constant defect dimension of 0.025mm. The scale has a true zero point as its origin, and the ratio of any two scale points is independent of the unit of measurement. Consequently, the M-L Scale represents measurements on a ratio scale, where each scale value is a "true" number with a true zero, and most importantly, the data collected may be analyzed by conventional parametric statistics.

In order to use any measuring instrument effectively, consideration must be given to both its accuracy and precision. "Accuracy" is the degree of conformity to some recognized standard value, while "precision" is the degree of agreement of repeated measures of a quantity.

The accuracy of the M-L Scale is readily definable as a function of the calibration of the original micrometer and the dimensional characteristics of the impression material and epoxy resin employed to replicate the micrometer head and produce the scale. However, in the interests of a universality of usage and to assure that all users of the scale achieve an acceptable level of precision, we feel it is essential that evaluators be calibrated with appropriate standards. Accordingly, for purposes of calibration, users will be provided with a set of 18 improved dental stone Calibration Standards. These standards were produced from the same impressions used to fabricate the M-L Scale.

Calibration to an acceptable level is performed by measuring the Calibration Standards with the M-L Scale on a blind random basis and achieving an 0.85 level of agreement, i.e. 85 percent of decisions should be correct.

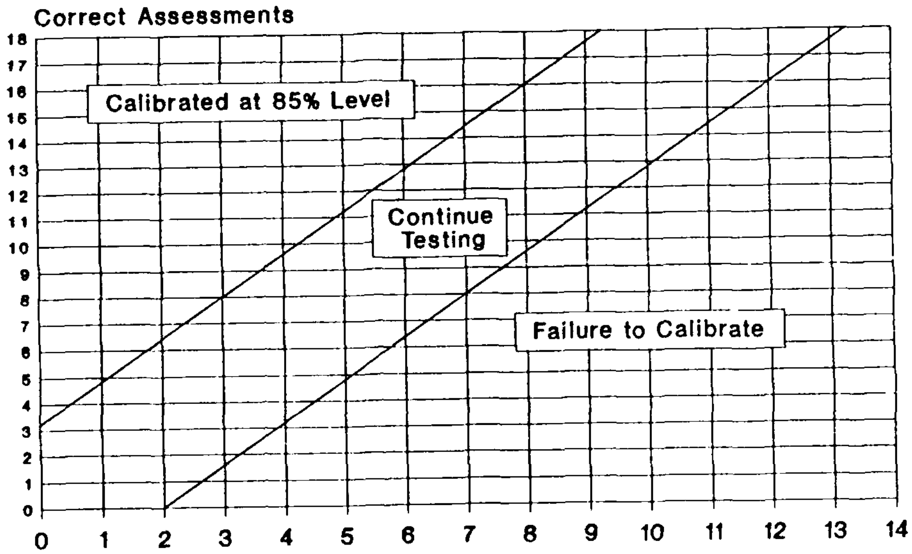
In the comparison process, a binomial decision is made. The evaluator's measurement will be either correct or incorrect. Accordingly, an incorrect decision will rate the Calibration Standard as either smaller or larger than the true value. On this basis, the null hypothesis (H_0) is that an unqualified evaluator will achieve an 0.33 level of agreement with the standard, i.e. only 1/3 of the decisions will be correct. As stated previously, the alternate hypothesis (H_1) is that a qualified evaluator will achieve an 0.85 level of agreement.

Fortunately, a relatively simple and powerful statistical procedure utilizing Sequential Analysis can be utilized to graphically test both hypotheses. We have provided an M-L Scale Calibration Graph (Figure 24) with which correct and incorrect assessments of randomly and blindly evaluated Calibration Standards may be plotted.

Figure 24

Sequential Analysis

M-L Scale Calibration Graph



The diagonal lines on the graph represent the boundary conditions which are a function of the relative probabilities of the null and alternative hypotheses and the acceptable Type I and II errors levels, i.e., rejecting the null hypothesis when it is indeed true, or accepting the null hypothesis when it is in fact false. After each operational decision, a determination is made as to whether the assessment is correct or incorrect. The cumulative correct decisions are plotted along the ordinate, and the cumulative incorrect assessments are plotted along the abscissa. As long as the plotted points remain between the diagonal boundary lines, no definitive decision can be made, and continued testing is required. However, a breakout above the upper boundary indicates that calibration at the 85% level has been achieved and sampling can be terminated. Similarly, when the points cross the lower boundary, testing can be ended, and it is indicative that the evaluator has failed to perform at an acceptable level. One of the major advantages of Sequential Analysis is that a fixed sample size is not required, and it reduces the amount of testing required for making a decision.

The M-L Scale has the following advantages:

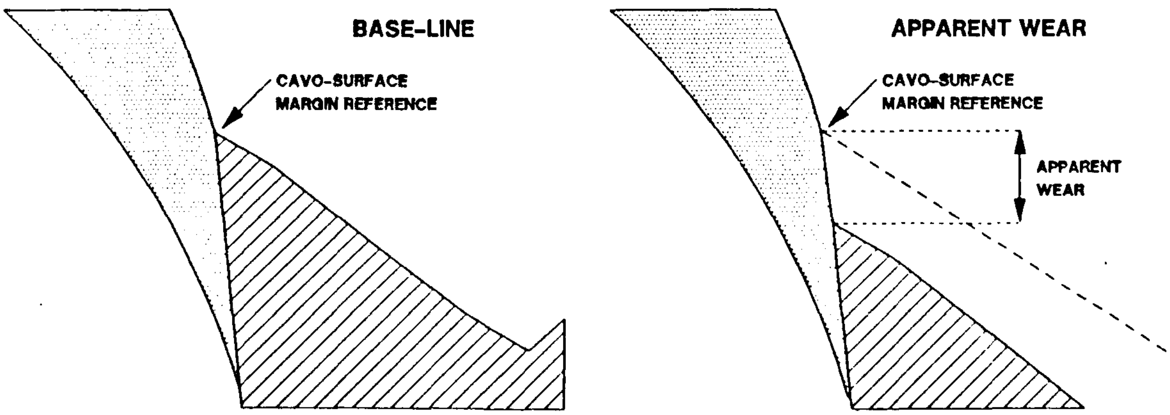
1. Each scale defect is uniform in depth and similar in appearance.
2. The intervals between scale units are based upon perceptual limitations.
3. The scale has a true zero, and scale units are on true ratio scale to the base 0.025mm.
4. Conventional parametric statistics may be used to analyze the data collected.
5. The accuracy to produce each scale unit is known.
6. Calibration with the provided standards assures that users will have comparable levels of precision of usage.
7. The scale lends itself to the early detection and measurement of occlusal loss.
8. The instrument utilizes simple perceptual skills which are compatible with clinical practice.

Like most instruments, the scale also has its limitations, which are the following:

1. Its use presumes that the apparent cavo-surface marginal loss of material is representative of the entire restoration.
2. Its use is dependent upon replicated casts of restorations and should not be used as a direct measurement tool.
3. Evaluators must be calibrated and have adequate depth perception.
4. The scale defects are geometric in design and do not resemble clinical restorations.

Figure 25

Base–Line and Apparent Wear



There have been numerous attempts to quantify occlusal wear of composites. The PHS criteria for anatomic form has been found to be relatively insensitive to assess occlusal wear. Intra-oral assessment is compromised by the similarity in color between tooth structure and composite material, the presence of moisture, diffuse intra-oral lighting which tends to mask discrepancies at the tooth-restorative interface, and limitations of optical magnification. Therefore, the more popular techniques as advocated by Leinfelder, Goldberg, and the M-L Scale procedure, utilize the assessment of replicas of the restored surfaces by means of standardized scales.

As illustrated in Figure 25, the use of these measurement systems focuses upon the composite resin-tooth structure marginal interface. At base-line, the prepared enamel cavo-surface margin is utilized as a reference location from which any loss in the composite resin may be measured by comparison with the standardized scales. If indeed there is wear of the composite restoration, then a flat area of enamel will become exposed and a measurement of the *apparent wear* is made from the cavo-surface enamel margin reference to the surface of the composite.

As can be seen in Figure 26, the *true wear* or vertical loss of composite material is at right angles to the surface of the restoration. In most instances, due to cuspal inclinations, the apparent wear visualized at the margins is greater than the true wear and varies as a function of the sine of the angle at the tooth-restorative material interface. Hence, at a 30 degree cuspal angle, the apparent wear can be 50 percent greater than the true wear. If the margins of the composite resin were beveled, as in Figure 27, then the discrepancy between true wear and apparent wear becomes even greater. If on the other hand, the restoration was overfilled beyond the cavo-surface margin reference, then the apparent wear can underestimate the extent of true wear. A rounded or worn cavo-surface margin is a further confounding feature of using the margins as point of reference (Figure 27). Non-discrete cavo-surface margins can result in an assessment of wear which can be either greater or less than the true wear.

When measurements are made of the wear at the margins of composite restorations it is not unusual to see considerable variation from one marginal area to the next within the same patient, and from patient to patient. These variations can be real, or they can be the result of a combination of the aforementioned factors. Therefore, we developed a technique which produced a quantified measurement of wear at right angles to the surface of the restoration in the central fossa areas.

After completion of the carving and polishing of the composite restorations, a small stainless steel pin was embedded in the fossa at right angles to the surface, luted in place with a non-filled bonding resin, and ground flush with the surface of the restoration. To be certain that this pin would serve as a reliable fiducial reference point, a small indentation was produced in it's center with a one-quarter round carbide burr. At yearly intervals, replicas of the surface were obtained from vinyl polysiloxane impressions and poured in an epoxy resin die material.

Figure 26

True Wear and Overfilled Restoration

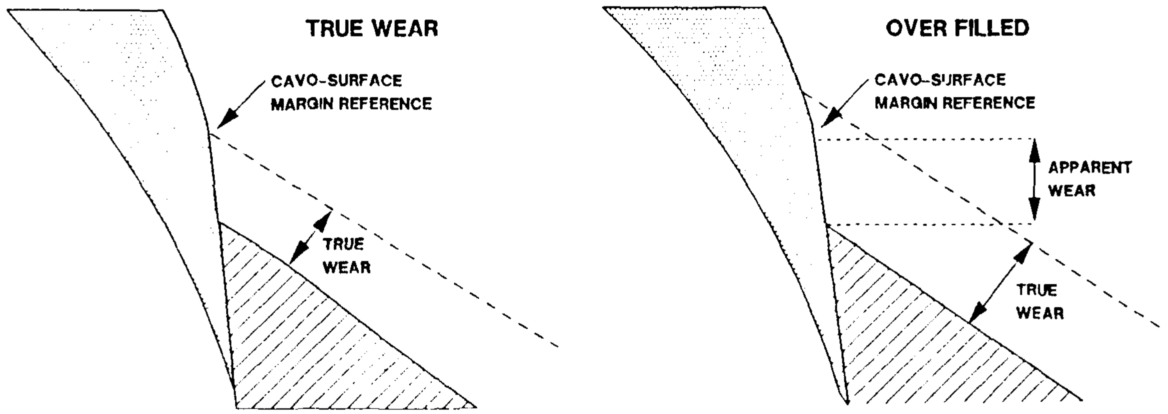
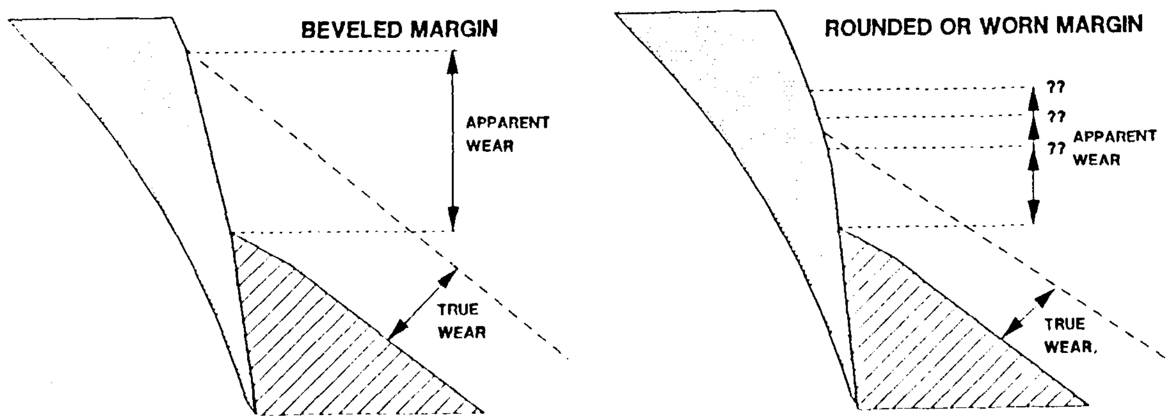


Figure 27

Beveled and Rounded Margins



The replicas were mounted on an precision X-Y translation table which was controlled by digital micrometers with a translation accuracy of 1.0 micron. A Mitutoyo Digimatic Indicator and a relatively inexpensive mini-processor was utilized to record the changes in dimension in the vertical "Z" axis. An initial vertical recording was made from the center of the stainless steel pin surface as the fiducial reference reading. Four additional recordings were also made 1.000mm equidistant from the pin in the "X" and "Y" directions. The pin's vertical dimension was subtracted from the mean of the lateral four recordings. Therefore, the measurements obtained represented the mean vertical loss of material in an area 2.000mm in diameter, in the central fossa of each restoration.

Figure 28

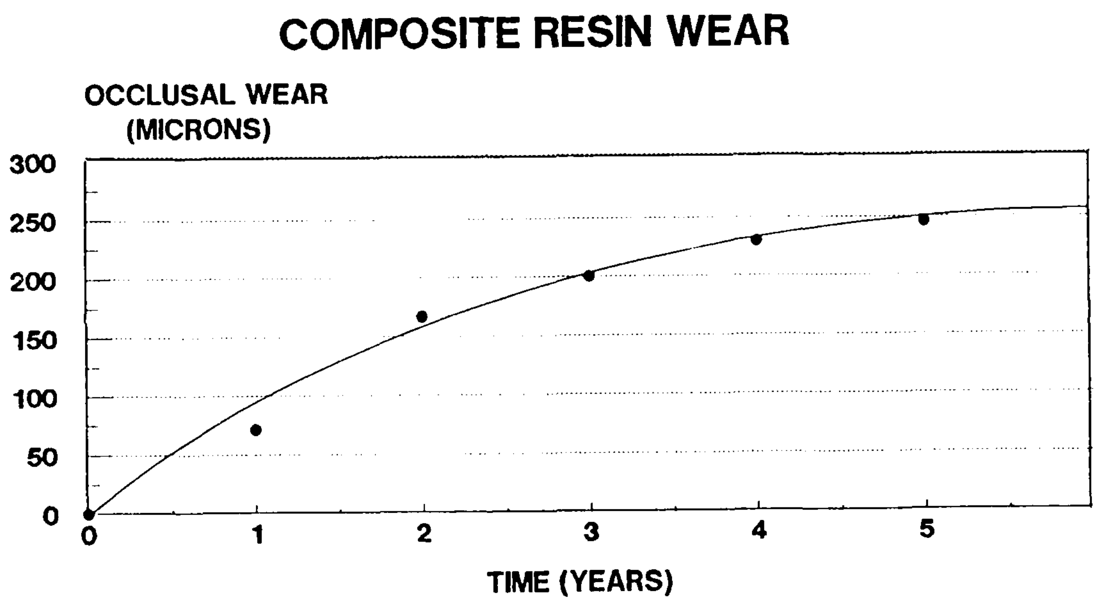


Figure 28 represents the mean vertical loss of material in microns over a five year period with one of the composite materials. A regression analysis was performed on this data and it showed that this composite material followed a logarithmic curvilinear behavior with time. It was apparent that there was a rather rapid initial loss of material during the first three years, which became less as time progressed.

One can only speculated as to the causative factors which might be responsible for this wear behavior. Machining of the surface during the finishing and polishing procedure may produce microdefects and/or residual stress in the surface which would predispose the polymer to premature deterioration. Exposure to air during initial polymerization, may produce a polymer with a gradient in physical and mechanical properties. Or indeed, it may be as simple as a less efficient food bolus effect as the vertical dimension between opposing masticatory surfaces increases. It may be a combination of any of the aforementioned factors, or none of them. Further research is needed to elucidate the mechanism of the wear process. In any event, at least for this category of composite material, a projection of wear based upon a linear model does not appear to be appropriate.

15. CLINICAL EVALUATION OF THE WEAR OF A COMPOSITE RESIN AND DENTAL AMALGAM

In collaboration with Dr. Michael W. Roberts, Chief, Patient Care Section and the staff at the Clinical Investigations and Patient Care Branch of the National Institute of Dental Research, a clinical study was conducted to determine the clinical performance and wear characteristics of a proprietary high copper amalgam alloy and a small particle bimodally filled hybrid composite resin (Herculite vs. Dispersalloy). Todate, a total of 53 composite resins and 55 amalgam alloys restorations have been placed in 34 patients, whose mean age was 58.9 years. There were 19 males and 15 female patients. All the restorations were of the Class II type. At the one year recall period 100 percent of the composite and 98.2 percent of the amalgam restorations were available for examination.

Table 16

DISTRIBUTION OF COMPOSITE AND AMALGAM RESTORATIONS

	Teeth		Surfaces		
	Premolar	*Molar*	2	3	4
Composite	35	18	31	18	3
Amalgam	27	28	30	20	5

The distribution of the restorations is shown in Table 16 and it illustrates a uniform assignment of the two restorative materials among the number of restored tooth surfaces. The majority of composite restorations appeared to have been randomly placed in premolars, while the amalgam restorations had a larger number placed in molars.

The materials were manipulated in accordance with the respective manufacturer's instructions recommending use of a rubber dam and a calcium hydroxide base where indicated. The teeth to be restored with the composite resin were etched with a 50% phosphoric acid gel and the manufacturer's proprietary bonding agent was employed on the exposed dentin and enamel margins. The amalgam alloy preparations received an application of a copal varnish and all amalgam restorations were polished 48 hours after placement.

All restorations were evaluated independently by two previously calibrated evaluators at base-line and at 12 months utilizing the PHS criteria for color match, cavo-surface marginal discoloration, anatomic form, marginal adaptation, and caries. In addition, impressions were taken of the restored occlusal surfaces utilizing a polyvinylsiloxane type impression material and improved dental stone casts were produced. The casts were coded and on a blind basis the extent of occlusal wear was measured, utilizing the previously described M-L Scale procedure.

A detailed summary of the data collected for this clinical study may be found in Appendix 2. The first part of this appendix provides specific individual patient information - the patient's identification number, sex, race, and age. The indicated date is the date of original placement of the restoration, followed by the tooth number, and the name of the dentist who placed the restoration. The groups of five letters and number represent the assessments for the PHS criteria and the M-L Scale measurement at base line and subsequent recall periods. If a single letter is found present, it represents the coded reasons for failure, previously detailed in Table 3.

The next section in Appendix 2, is a summary of the distribution for each of the five PHS criteria. The first section summarizes the distribution at the base-line (Period # 0) and at the first yearly recall (Period #1). The subsequent sections provide valuable information on the distribution of failures due to related, unrelated, and patient complications. Finally, there is an overall summary of the number or restorations which either deteriorated, improved or showed no change from the base-line to the subsequent evaluation periods.

Over the brief one year period of observation, there was a slight improvement in the color matching capabilities of the composite resin, 79 percent Alpha at base-line vs. 85 percent Alpha at one year recall period. This type of "so-called" improvement is usually caused by restorations which were judged to be too light at base-line which darkened with time to more closely approximate the color of adjacent tooth structure. The change in color was not statistically significant.

However, there was a statistically significant increase in the incidence of non-penetrating type of marginal discoloration. At base-line 30 percent of the composite restorations showed evidence of Bravo type marginal discoloration versus 50 percent marginal discoloration at the one year recall period. It was interesting that the change in marginal staining occurred in spite of the use of the manufacturer's so-called "bonding agent".

There were no statistically significant changes in loss of anatomic form (wear), marginal adaptation, or caries from the base-line to the subsequent one year recall period for either the composite resin or the dental amalgam restorative materials.

As mentioned previously, accurate replicas of the occlusal surfaces of both the composite resin and the dental amalgam restorations were evaluated on a blind basis by use of the M-L Scale technique. The results of measurements made at base-line and at the one year period may be found in Table 17.

Table 17

M-L SCALE MEASUREMENTS OF THE WEAR OF A COMPOSITE RESIN AND DENTAL AMALGAM

	Restorative Materials	
	Composite Resin	*Amalgam Alloy*
BASE-LINE		
Mean	4.31	7.46
S.D.	4.04	4.13
ONE YEAR		
Mean	6.15	7.44
S.D.	4.89	4.91
WEAR		
M-L Values	1.84	-0.02
Microns	46.0	0.5
Paired t-Statistic	2.6754	0.0000
Probability	0.0050	Not Sig.

A comparison of the M-L Scale values in Table 17, revealed that the amalgam alloy had a marginal loss at the base-line period which was 7.46 M-L units (each M-L Unit equals 25 microns). At the same base-line period, the composite resin was judged to have an occlusal defect which was equal to 4.31 units. An independent t-Test was conducted to compare the amalgam alloy and composite resin base-line M-L Values. The resulting T Statistic of 3.9798 revealed a very highly significant difference (probability = 0.0001) between restorative materials at the base-line period.

This study shows for the first time, that the normal restoration polishing procedure produces a mean occlusal defect of 187 microns for the amalgam alloy, and a statistically smalle· defect of 108 microns for the composite resin. In view of the relatively broad range of defects, even among the same restorative material, it is important to compare each restoration with itself to assess a time dependent wear phenomenon.

Accordingly, the paired t-test was utilized to determine the statistical significance of the wear of each of the two restorative materials. The results of this statistical test revealed that there was a highly significant difference in the change in the occlusal surface of the composite resin restorations during the brief one year period of observation (probability = 0.005). In contrast, there was no significant change in the occlusal morphology of the amalgam alloy tested (probability less than 0.05).

It was significant to note that the PHS criteria *did not detect* any change in the wear properties of either material and produced a false negative assessment of the wear. This clinical study of an amalgam alloy and a composite resin provides evidence of the utility of the M-L Scale to quantify wear.

16. QUANTIFICATION OF THE PARAMETERS OF THE CENTRIFUGAL CASTING PROCESS

It is apparent that the extraordinary incidence of caries associated with the gold and base metal alloy fixed prosthodontic restorations was partially attributable to the fit of the castings. Laboratory technical personnel have voiced differing views relative to the casting ability of these alloys. The ability to cast fine marginal detail and accurately replicate intricate dental structures is a function of a multitude of factors. Although the majority of these factors have been quantified, and recommendations for their control have been made, the final centrifugal casting process is still conducted on a highly subjective basis. Therefore, we have conducted a laboratory study to accurately quantify, for the first time, the parameters associated with the centrifugal casting procedure.

To monitor acceleration, an accelerometer was mounted within a weighted casting ring to simulate the mass of a typical invested crown. In order to provide electrical continuity of the accelerometer's signal during rotation of the casting arm, a special slip ring assembly was designed. The lower end contained a internally threaded adapter which could replace the nut or bolt used to secure any casting machine arm to its spring activated shaft. To monitor the torque induced during the casting process, a dynamometer was attached between the casting machine's spring activated shaft and the casting arm. To monitor the angle of rotation of the casting arm, the upper end of the slip ring assembly housed a magnetic pick-up device which was in proximity to a sixty tooth gear. Thus, each signal peak detected, corresponded to six degrees of angular rotation. With the instrumentation described, we were able to simultaneously monitor torque, acceleration, and angle of rotation. The signals from these three transducers were recorded on a multichannel fiber optic photographic oscillographic recorder.

The effect of a number of turns upon acceleration developed by two different manufacturer's spring wound casting machines may be found summarized in Figure 29. We found, as this graph illustrates, that the 'G' force developed by each casting machine was unique to that machine and was as highly reproducible as fingerprints. Therefore, it is understandable that technicians using different machines will report conflicting results relative to the casting ability with the same alloy. It is important to separate casting machine effects from alloy effects.

The relationship between the torque stored within the spring and the acceleration, as expressed as 'G' force, is illustrated in Figure 30. As noticed, both relationships follow a geometric curvilinear relationship whose correlation coefficient was 0.9999. The effect of the number of wind-up turns and the stored torque and resultant 'G' force is shown in Figure 31. When the energy in the spring wound arm is released, both torque and developed 'G' force follow reciprocal relationships which are shown in Figure 32. We found that the time interval between the start of rotation and maximum 'G' force can range between 0.40 to 0.75 seconds, depending upon the length of the casting arm, its distribution of mass, and the spring's torque characteristics.

Figure 29

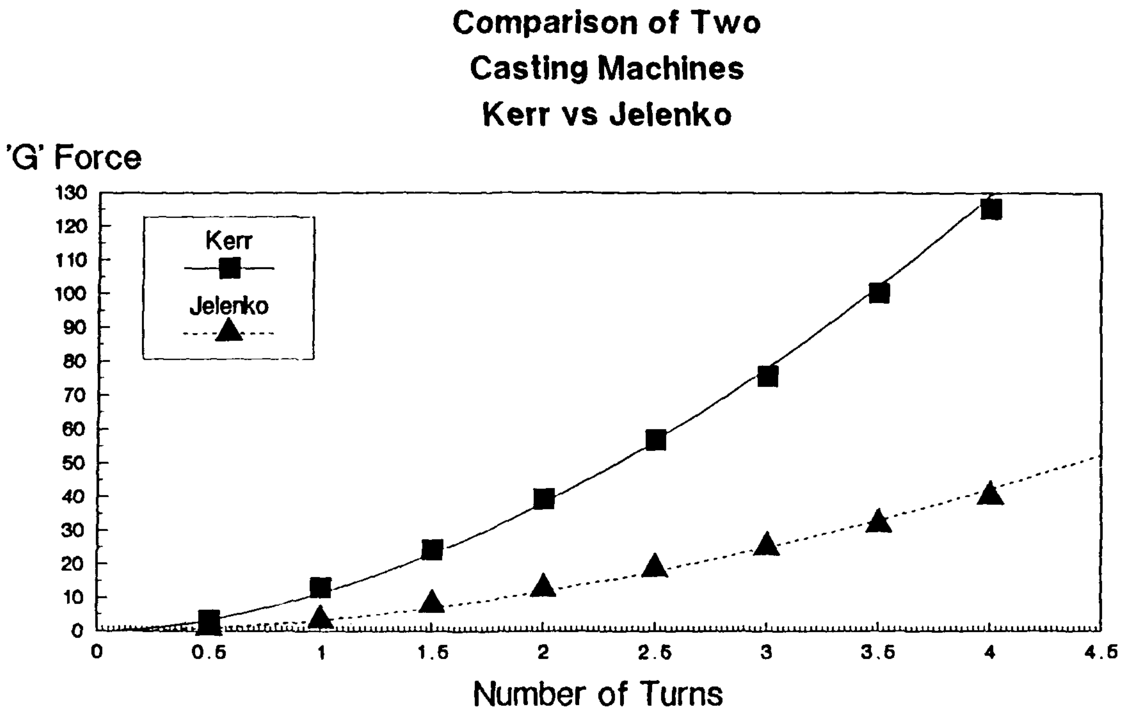


Figure 30

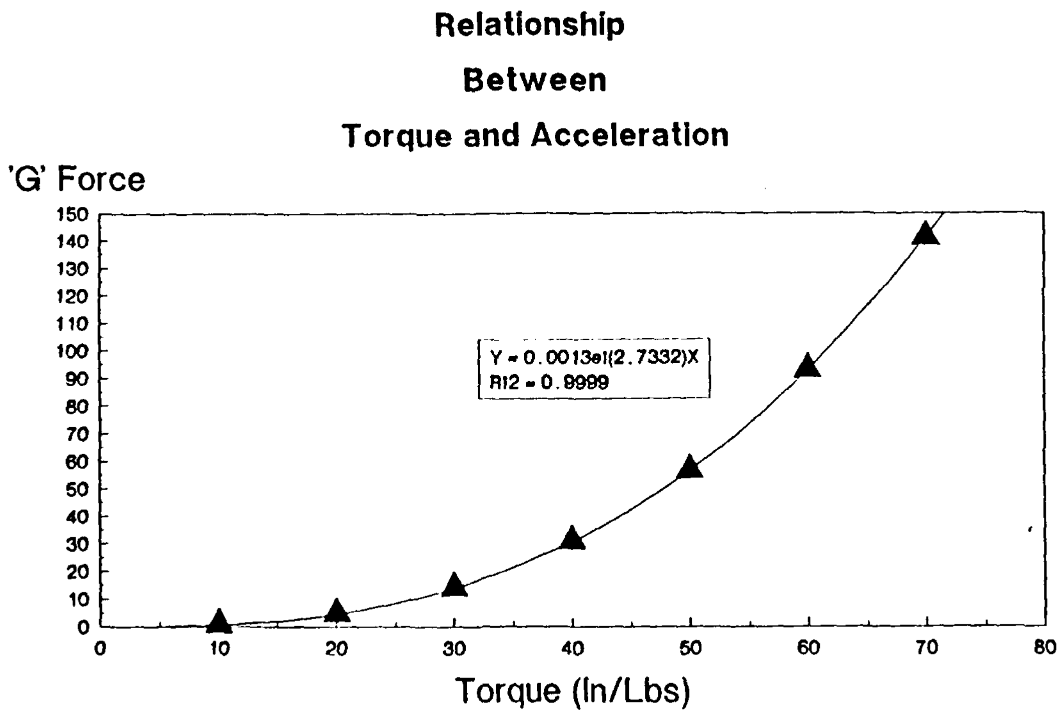


Figure 31

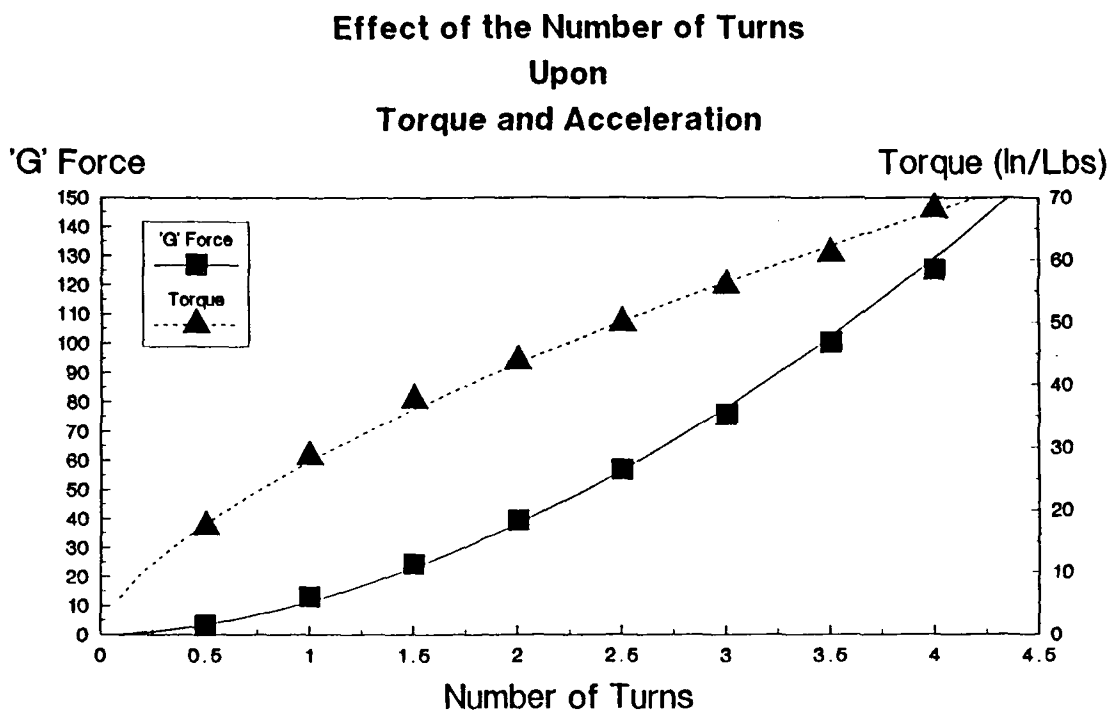
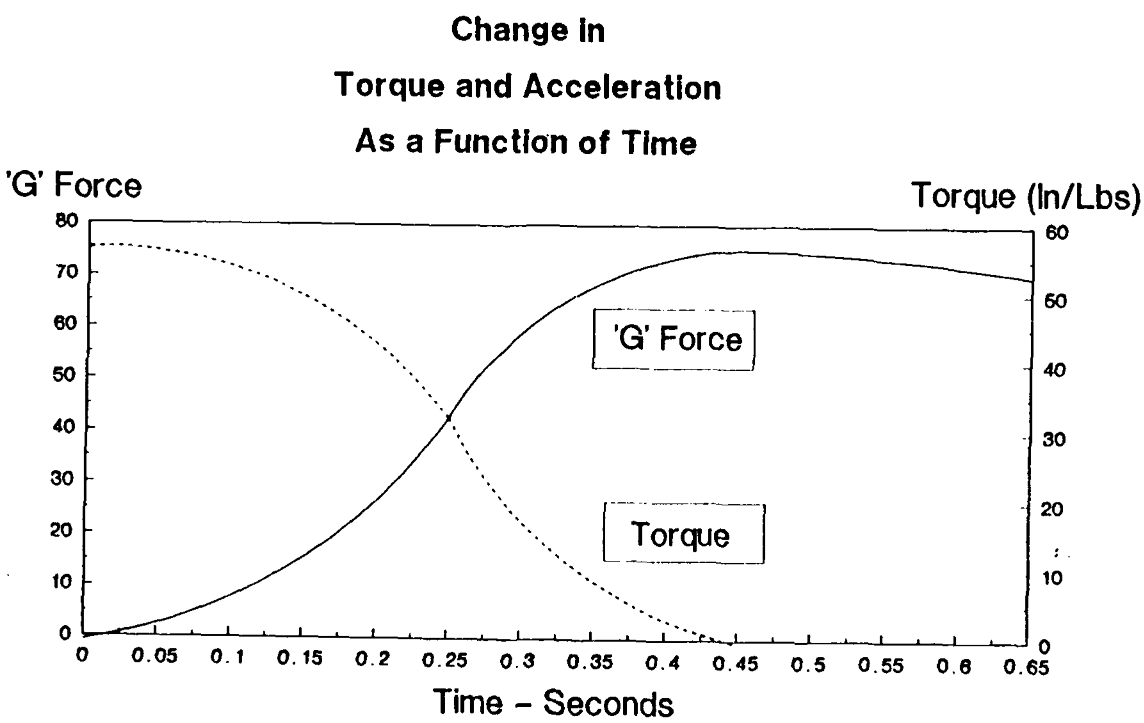


Figure 32



For a fixed arm casting machine, there is a linear relationship between time and the achievement of maximum 'G' force. Interestingly, for a broken arm machine (such as the Kerr machine) a unique oscillation in acceleration is produced as a function of time. This oscillation, as confirmed by stroboscopic photography, is caused by the broken arm segment moving back and forth during rotation. As illustrated by Figure 33, there is an exponential curvilinear relationship between 'G' force and time during deceleration, which is also unique for each casting machine.

Traditionally, the longer casting arms of machines used for casting partial dentures were assumed to develop higher casting force. As illustrated in Figure 34, we found just the opposite to be true, i.e., increasing the arm length actually results in a decrease in 'G' force production. Why should this occur? It is important to recall that there is only a finite amount of torque available due to winding the spring. By making the casting arm longer, we must also increase its mass. Because of the lever arm effect, the counter weight necessary to balance the arm must also be increased, and most importantly, the mass is distributed further from the axis of rotation. Unfortunately increased arm length, increased mass, and the distribution of the mass, increases the energy required for rotation. Since the energy available is fixed, there is a resultant reduction in acceleration. A further complication is the increased wind resistance which might be expected by a larger versus a smaller arm. The same principles involved here are responsible for a spinning ice skater picking up speed of rotation as the skater's arms are retracted toward the body. Therefore, contrary to popular belief, higher 'G' force may be produced by redesign of spring wound casting machines with a shorter arm.

Our controlled laboratory studies of the parameters associated with spring wound casting machines have shown the following:

1. The acceleration as a function of time and the number of windings unique for each casting machine and are highly reproducible.
2. The broken arm casting machine produces a unique oscillation in acceleration, as a function of time.
3. Maximum acceleration for all casting machines is achieved at the same number of arm rotations as the initial spring windings.
4. Depending upon arm length, distribution of mass, number of windings, and spring torque characteristics, maximum acceleration can be achieved within 0.40 to 0.75 seconds.
5. There is a geometric curvilinear relationship between both torque and acceleration and the number of spring windings.
6. Deceleration with time follows an exponential curvilinear relationship which is unique for each casting machine.
7. With knowledge of the casting characteristics of each machine, it should be possible to produce casting force time relationships which are optimum for each casting alloys.

Figure 33

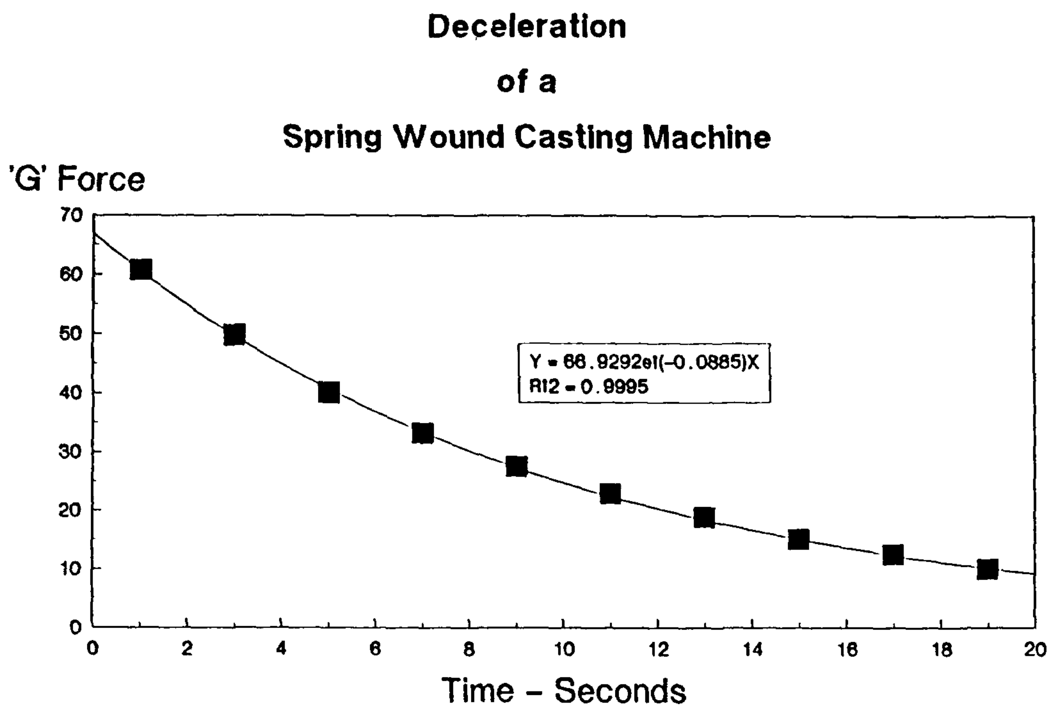
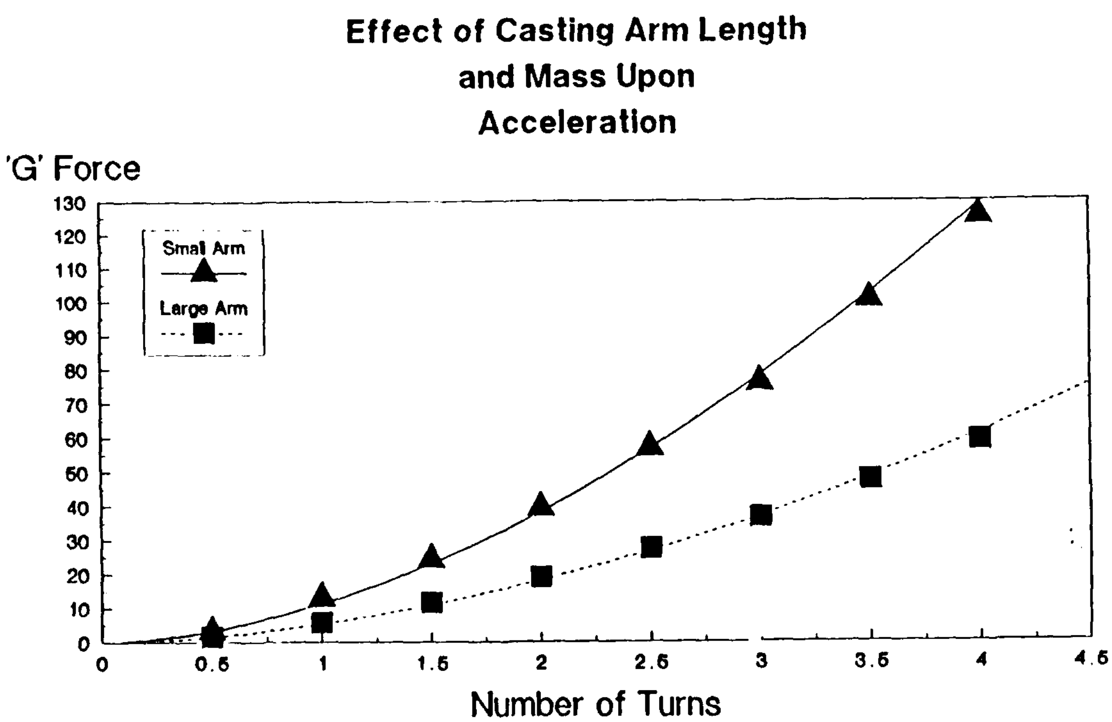


Figure 34



II. CLINICAL EVALUATION OF A TEST HYDROPHOBIC COMPOSITE RESIN

1. RATIONAL FOR THE USE OF A HYDROPHOBIC COMPOSITE RESIN RESTORATIVE MATERIAL

The clinical deficiencies of silicate cements and unfilled polymethylmethacrylate resins prompted the development and use of composite resin dental restorative materials. Although the current composite resins based upon BIS-GMA formulations were developed in response to problems of solubility, poor strength, etc., they are not without deficiencies of their own. As shown by numerous investigators, contemporary composite resins suffer from problems associated with excessive marginal discoloration and leakage, inadequate color stability, recurrent caries, and poor stain and wear resistance. These gross clinical deficiencies are in all probability related to the mechanical and chemical properties of the resin matrix material and inorganic filler particles.

There is reason to believe that the work of Wu and McKinney indicates that chemical degradation of the polymer matrix may be a critical factor contributing to the wear of dental composites both in stress bearing and stress free application. It is reasonable to assume that the complex interaction of composite restorations with the many chemical substances found in the oral cavity can be a diffusion-controlled process which initially leads to hydrolytic degradation and ultimately to chemical breakdown of the polymer matrix. Since they exist in a predominantly aqueous environment, the transport of chemical substances into the polymer phase is likely to be water assisted.

The relatively hydrophilic BIS-GMA or urethane methacrylate copolymers have solubility parameters similar to certain food derived chemical substances found in the oral cavity. Therefore, current composites based on these systems display an affinity not only for water, but also for many of the chemical substances generated intraorally. The complex sorption process that occurs in these composites may induce not only stresses but also chemical degradation reactions such as poor color stability, surface staining, and marginal leakage that accelerate the failure of these restorative materials.

In view of the potentially deleterious effects of the aqueous environment in which composite resins are expected to function, it would appear appropriate to develop and assess the clinical performance of a hydrophobic resin system. A hydrophobic composite developed by Craig, et. al. represents a polymer system which addresses the previously outlined deficiencies. Unfortunately, the polymer developed by this group of investigators also has problems associated with high polymerization shrinkage and low mechanical strength.

Recently, the group at the National Bureau of Standards, which is also supported by an Interagency Agreement from NIDR, developed a hydrophobic composite resin. This resin which is based on the polyfluorinated oligomeric multifunctional methacrylate (PFMA) appears to offer certain advantages over previous resin systems. As reported recently, this resin is extremely hydrophobic, has low water sorption, has significantly greater mechanical properties, and due to the prepolymer nature of the principal monomeric component

PFMA, should yield low polymerization shrinkage.

A study of water sorption and microleakage showed that the new PFMA resin system offered significant advantages over five proprietary and three experimental resin systems tested. This group found that the water sorption of the proprietary materials ranged from 0.4 to 1.6 mg/cm, as compared to only 0.13 mg/cm for the highly fluorinated PFMA. In the past, previous investigators have questioned whether hydroscopic expansion might be advantageous in that it may be used to compensate for polymerization shrinkage. Hence the decrease in water sorption might be counter productive. However, the work by Dermann, et. al. has shown that increased water uptake does not result in a significant improvement in marginal adaptation. Indeed, the microleakage study by Venz, et. al. corroborates this finding to show that the most hydrophobic materials, i.e. those with the least water sorption, also had the least evidence of microleakage. The reduced microleakage is also in agreement with the theoretical predictions of the surface energies in the crevices involved and capillary phenomenon described by O'Brien.

There is a need to develop and clinically evaluate composite resins which are color stable, resist surface staining, have improved mechanical properties, minimize marginal leakage and the hazards of secondary caries and pulpal irritation. Therefore, this clinical study was initiated to evaluate the hydrophobic PFMA resin developed at the National Bureau of Standards.

2. DESCRIPTION OF THE EXPERIMENTAL METHOD TO ASSESS CLINICAL PERFORMANCE

The objective of this clinical study was to evaluate the clinical performance of a test hydrophobic resin based upon a PFMA formulation as compared to a control proprietary non-hydrophobic BIS-GMA formulation for the restoration of anterior teeth. The proprietary product, Adaptic (Johnson and Johnson Dental Products Company), was selected for the control restorative. This commercial restorative material utilizes quartz filler particles which are similar to the filler used in the test hydrophobic composite resin. As previously described in section I-2, the PHS ordinal rating system and our clinical computer system were utilized to assess the clinical performance of the test and control composite resin restorative materials. The conduct of the controlled clinical study was conducted with particular emphasis placed upon the assessment of color stability, cavo-surface marginal discoloration, leakage, and caries. Base-line clinical evaluations were performed one week after the restorations were completed, and then at 6 and 12 month intervals on a blind basis by two independent trained examiners.

The test material was formulated and produced at the National Bureau of Standards by its developer, Dr. Joseph Antonucci. Our laboratory has been dependent upon the NBS group for the synthesis of the polymer, formulation of the filler, inhibitors, color stabilizers, etc., and the production of a polymeric system which was suitable for clinical evaluation. Although this NBS group was successful in producing relatively small quantities of the polymeric system for their in-vitro testing, they encountered significant difficulties when they attempted to produce the larger quantities required for preliminary biocompatibility and subsequent clinical evaluation. To be specific, Dr. Antonucci found that the first larger production batches had short shelf-life and were subject to premature autopolymerization. Accordingly, he had to purify the monomer and modify the inhibitors and stabilizers to eliminate the problem of premature autopolymerization. Correction of this problem was further compounded by a personal injury which Dr. Antonucci sustained delaying the production of the polymeric system until March 4, 1985.

Sufficient quantities of materials were then produced to conduct both the biocompatibility tests and the clinical performance studies from the same batches of materials. Biocompatibility tests have been conducted by the Microbiology Branch, U.S. Army Institute of Dental Research, Walter Reed Army Medical Center. The results of these tests indicate that the biological safety of the test PFMA formulation is comparable to proprietary resins currently being used in dentistry. The test composite resin has undergone product quality assurance and characterization tests at NBS. These tests included: diametral tensile, compressive strength, water sorption, hardness, color stability, infra-red spectrum, NMR, filler particle size distribution, wear characterization, viscosity, working, and setting times.

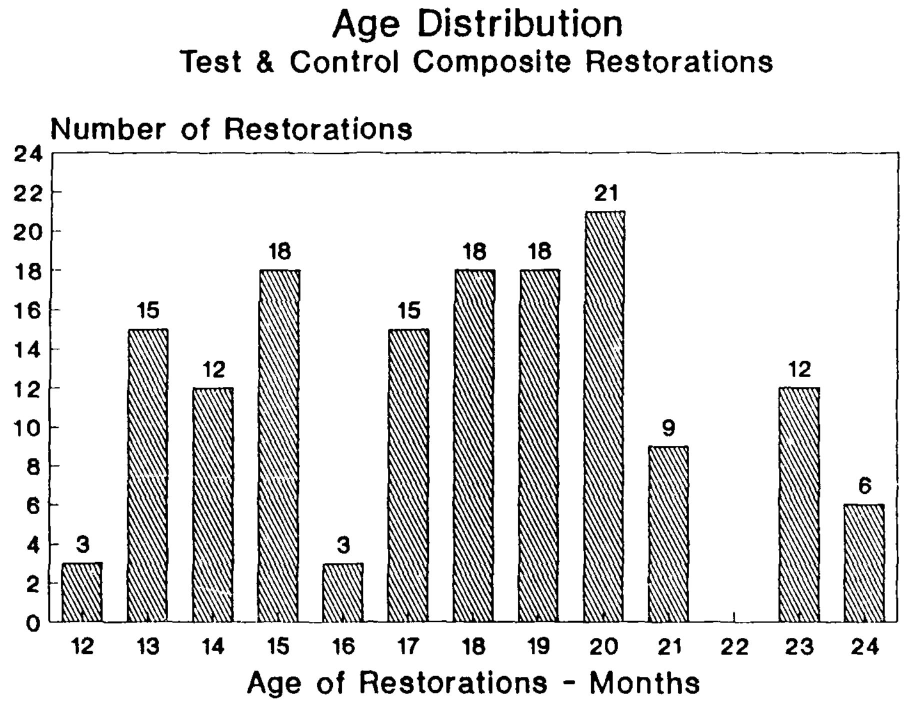
We have given consideration as to whether the effects of acid etching of dental enamel should be tested with both the test and control materials. We feel there is adequate evidence to indicate that the use of acid etching will reduce the incidence of marginal discoloration associated with conventional proprietary BIS-GMA composite resins. The questions addressed were whether the hydrophobic nature of the PFMA was adequate to eliminate or reduce marginal discoloration and leakage in the absence of acid-etched enamel surfaces, or whether acid etching was also required with the new PFMA resin. Therefore, we clinically evaluated three categories of restorations:

1. PFMA test resin restoration with acid etching
2. PFMA test resin restoration without acid etching
3. Adaptic control resin restoration with acid etching

The clinical study involved the placement of fifty (50) replications for each test and control group, for a total of 150 restorations. All three categories of restorations were placed within the same patient's oral cavity.

PATIENTS: Fifty adult patients, 31 male and 19 female, were identified who required three interproximal restorations of their anterior teeth. The ages of these patients ranged from 25 to 77 years, with a mean age of 53.4 years. Of these 84 percent were Caucasian; Asians and Blacks each represented eight percent of the population. As illustrated in Figure 35, the 150 test and control restorations were placed over a 12 month period from May 1986 through May 1987.

Figure 35



CAVITY PREPARATION: Cavity preparation for all restorations was performed utilizing conventional techniques. A rubber dam was used to isolate the anterior teeth. Conservative preparation of the cavities was accomplished using carbide burs to remove all caries and old restorative material. Whenever possible, a bevel was cut with a coarse diamond point along the cavo surface enamel margin. The bevel formed was at approximately 45 degrees to the tooth surface and was .25mm to .50mm in width. If insufficient undercuts were present to retain the restorative, undercuts were placed to insure mechanical retention of the restoration. A base, Caulk Dycal (The L. D. Caulk Company), was placed on the deepest exposed dentin.

The outline form and size of each of the three cavities was unique, being dictated by the extent of tooth destruction. Since each of the three cavities was in a different restorative category, operator bias was eliminated by utilizing a random table to assign restorative to cavity preparation. The two cavity preparations assigned to be acid etched were isolated utilizing plastic Uni-Strips (The L. D. Caulk Company). Etching of the enamel was accomplished utilizing 37% phosphoric acid, Kerr Acid Etchant (Sybron/Kerr), for 60 seconds followed by a minimum of a 15 second water rinse. All cavity preparations were dried before restorative material was placed.

RESTORATION: Each of the three cavity preparations was individually filled with a fresh mix of the assigned restorative. Prior to filling, a plastic Uni-Strip was contoured and wedged tightly against the tooth with a wooden wedge. All restorative materials were mixed on the paper pad packaged with the Adaptic resin. All restorative materials were stored refrigerated and allowed to come to room temperature before being dispensed for clinical use. The Adaptic restorative was dispensed and mixed according to manufacturer's directions. The test Hydrophobic PFMA resin was dispensed and mixed according to instructions provided with the restorative. The Hydrophobic PFMA resin system consisted of a liquid resin dispensed from it's plastic dropper bottle, and a fine powder dispensed with a plastic spoon. The suggested ratio for mixing was two drops of resin (32mg) to one scoop of powder (100mg) yielding a P/L ratio of 3:1. Initially during laboratory mixing of the Hydrophobic PFMA resin, we were not always able to produce a mix of the desired consistency. We found that the liquid resin must be dispensed with the squeeze bottle in a critical vertical orientation to consistently produce 16mg drops. To produce 100mg portions of powder, the scoop had to be gently vibrated to settle the powder and the excess scraped off level with the top of the scoop.

All restoratives were delivered into the cavity preparation utilizing a C-R Syringe (Centrix, Inc.) with the disposable plastic tip trimmed to ensure unrestricted flow of the liquid restorative. Following overfill of the cavity preparation, the matrix strip was pulled tight and held in place for two minutes. Finishing was delayed until all three restorations had been placed. No restoration was finished unless it had at least five minutes to complete the chemical cure. Gross excess was removed with rotary abrasive points or fine diamond points. Final finish of the restoration was accomplished with Sof-Lex (Dental Products/3M) discs and strips. Due to the coarse surface texture of these large particle composite resins, a smooth polished surface was not obtained. Emphasis was placed on removal of excess restorative and not over heating or over instrumenting the restoration.

3. THE CLINICAL PERFORMANCE OF THE HYDROPHOBIC COMPOSITE AT 6 AND 12 MONTHS

CLINICAL PROPERTIES: Differences between the test Hydrophobic PFMA and Adaptic restoratives were noted during clinical placement. The consistency of the Adaptic after mixing was a stiff paste that would not slump under its own weight. The Adaptic required firm pressure to extrude from the C-R Syringe. The consistency of the Hydrophobic PFMA resin after mixing was a smooth paste that was thick enough to load into the C-R Syringe but fluid enough to slump under its own weight. The Hydrophobic PFMA resin flowed easily from the C-R Syringe. The Adaptic would harden quickly, in a "snap-set" fashion, while under the matrix strip for the required two minute period. The Hydrophobic PFMA resin mix would gradually harden. By the end of the two minute interval, the matrix would pull away cleanly. The excess Hydrophobic PFMA resin, where not covered by the matrix, had a thick layer of unpolymerized restorative on the surface. The Adaptic was difficult to finish. Carving away excess material without exposing cavo surface margins was difficult with tooth colored large particle quartz restorations. A smooth surface was not produced with fine abrasives. The Hydrophobic PFMA resin shared all the finishing problems encountered with the Adaptic. In addition it seemed slightly softer while finishing down the restoration.

The "universal shade" of the Adaptic resin was lighter than some patient's teeth (18 of the 50 restorations rated "b" at baseline). Even when the shade was evaluated as light, the patients' acceptance of the restorations was excellent. The shade of the Hydrophobic PFMA resin was indistinguishable from the Adaptic when the restorations were wet; 24 of the 100 restorations were rated "b" at baseline.

BASELINE: One week after placement, each of the fifty patients was recalled for baseline evaluations. The conventional PHS criteria for color match, cavo surface marginal discoloration, anatomic form, marginal adaptation and caries was utilized to assess clinical performance by use of this ordinal rating system. If a "Bravo" rating for color match was detected, a determination was made as to whether the restoration was darker or lighter than the adjacent tooth structure. If a restoration was darker, the entry into our clinical computer system would be an upper case "B"; and in the event the restoration was lighter it received a lower case "b".

Baseline, 6 and 12 month examinations were performed independently and on a blind basis by two examiners. Each of the two examiners entered their ratings directly into the computer terminal located in each operatory. The ratings were performed without knowledge of the identity of the restorative material being evaluated, nor the ratings given by the other evaluator. In the event of a disagreement, the computer has been programmed to seek a consensus rating. Computer programs have been written to analyze the level of agreement between examiners for all criteria, and to analyze each examiner's agreement with the consensus.

An impression was taken of the study restorations and the adjacent teeth at each evaluation period. The teeth and restorations of interest were cleaned with a water slurry of flour pumice applied with a rotation rubber cup. The area was rinsed and dried. A putty-wash impression material was used to capture the surface detail at the margins of the restoration for quantification of any wear and for SEM examination. The replica impressions were poured in dental stone. We plan to use the resultant casts to identify and quantify the surface wear of the restorations. After the older casts have been made, or sooner if excessive wear is noted, we will review all serial casts of each restoration and identify an area of the margin which typifies the amount of wear observed. This area will be marked on each serial cast and a M. L. Value will be assigned to each restoration at each evaluation period. The M. L. Value is determined by visual comparison of the margin defect at the designated area of the cast with a series of calibrated defects, the M. L. Scale. The defect on the scale that most closely matches the margin defect becomes that stone cast's M. L. Value. The M. L. Value times 25 microns represents the amount of cavo surface wall exposed.

As previously described in Section I-15, the detailed descriptive statistics of the clinical data associated with this clinical study may be found in Appendix 3. This appendix details individual patient's restorations and rating distribution for each test and control restorative material. A summary of the distribution of the changes in ratings between the base-line and subsequent 6 and 12 month evaluations may be found in Table 18.

Table 18

DISTRIBUTION OF CHANGES AT 6 & 12 MONTHS

	HYDROPHOBIC		HYDROPHOBIC-ACID		ADAPTIC CONTROL	
	6 MO.	12 MO.	6 MO.	12 MO.	6 MO.	12 MO.
COLOR MATCH						
IMPROVED	0	0	0	0	0	0
DETERIORATED	0	0	0	0	0	0
NO CHANGE	49	46	49	46	49	46
MARG DISCOLOR						
IMPROVED	0	0	0	0	0	0
DETERIORATED	8	13	1	3	1	3
NO CHANGE	41	33	48	43	48	43
ANATOMIC FORM						
IMPROVED	0	0	0	0	0	0
DETERIORATED	5	12	4	8	2	1
NO CHANGE	44	34	45	38	47	45
MARG ADAPT						
IMPROVED	0	0	0	0	0	0
DETERIORATED	0	1	1	1	0	1
NO CHANGE	49	45	48	45	49	45
CARIES						
IMPROVED	0	0	0	0	0	0
DETERIORATED	0	0	0	0	0	0
NO CHANGE	49	46	49	46	49	46

At the present time 49 of the 50 patients have been examined after 6 months, and 46 patients after 12 months, i.e. 98 and 92 percent evaluation rate, respectively. Over the 12 months of evaluation, there was no change in the color matching capabilities of the two test hydrophobic and control restorative materials. However, in the evaluation of marginal discoloration at the 6 month interval, 8 of the Hydrophobic PFMA restorations without acid etching and only 1 of the 49 Hydrophobic PFMA with the acid etch treatment deteriorated from "A" (no marginal stain) to "B" (visible marginal stain). It would appear that without the use of an acid etch procedure, approximately 16.3 percent of the Hydrophobic PFMA restorations showed evidence of marginal leakage, as compared to approximately only 2 percent marginal leakage with the acid etch procedure. At the longer 12 month interval, the incidence of discoloration increased to 28.3 percent of the non-acid etched restorations. Therefore, during the period of observation, the hydrophobic nature of the test Hydrophobic PFMA resin did not appear to inhibit marginal leakage and the acid etch procedure still appears to be necessary. The incidence of marginal discoloration of the acid etched hydrophobic restorations was relatively low and identical to that experienced by the control Adaptic material.

In the category of loss of anatomic form, between 17.4 - 26.0 percent of the Hydrophobic restorations showed a change from "A" (no catch of the margin) to "B" (detectable catch of exposed cavo surface margin). During this same 12 month period, only 2 percent of the control Adaptic restorations showed any evidence in change in anatomic form.

In the category of marginal adaptation, there was no difference between the test and control restorative materials. Only 2 percent of both the test Hydrophobic and control Adaptic restorations showed any change from "A" (no catch of margin) to "B" (detectable crevice between restoration and cavo surface margin). Similarly, there was no evidence of any caries with either the test or control composite materials.

CONCLUSIONS During the 12 month period of observation, there was a trend toward increased marginal stain and surface wear of the teeth restored with the Hydrophobic PFMA material. There does not appear to be any evidence that the hydrophobic nature of the test composite resin will eliminate the need for the acid etch procedure. In all five areas of assessment - color match, marginal discoloration, anatomic form, marginal adaptation, and caries - the control Adaptic proprietary restorative material was either equal to or superior to the clinical performance of the test hydrophobic materials.

III. CLINICAL EVALUATION OF A CASTABLE CERAMIC MATERIAL

1. RATIONALE FOR THE USE OF A FIXED PROSTHODONTIC CASTABLE CERAMIC MATERIAL

Dental porcelain is unexcelled as the material of choice to produce esthetic individual crowns. The material is insoluble in the fluid of the oral cavity, extremely wear resistant, a thermal insulator, and possesses excellent properties of bio-compatibility. Coupled with these desirable mechanical, physical and biological properties, is the material's unique capability to simulate the translucency and color distribution of natural tooth structure. As a consequence, porcelain is still the procedure of choice when esthetic realism is the prime goal of a dental restorative procedure. Currently 40 percent of dental health dollars spent for dental laboratory services is attributed to porcelain jackets and ceramic crowns.

Unfortunately, the technique of producing porcelain jacket crowns by conventional means requires a high degree of technical skill. A multitude of layers of porcelain must be blended to achieve the desirable levels of value, hue and chroma necessary to simulate the lifelike colors of the gingival, body and incisal portions of natural tooth structure. As a consequence, only 23 percent of the laboratories are using high-heat 2300 degree F. porcelain for porcelain jacket crowns.

To produce a porcelain jacket crown with conventional porcelain is a time consuming process requiring a high degree of technical skill and artistic talent. An expensive platinum foil of a thickness of 0.001 inch must be closely adapted to an accurate stone replica of the patient's prepared tooth. This platinum foil matrix serves as a removable vehicle to which the various layers of porcelain slurry powder may be applied and later removed for thermal heat treatment in a special vacuum oven. Each increment of porcelain slurry must be vibrated to remove voids and partially dried to remove excess water. The porcelain powder must be added to excess, to allow for shrinkage encountered during the many firing operations. The crown and the underlying platinum matrix is then subjected to a multitude of firings in a furnace to mature the ceramic. Finally, to further characterize the crown, superficial stains are also added and the crown is subjected to a final firing.

In addition to the time and skill required to produce a conventional porcelain jacket crown, there are also certain deficiencies which are inherent in the technique. Bubbles or voids inadvertently incorporated in the crown not only adversely affect the esthetics, but also act as areas of stress concentration. Under the influences of the forces of mastication, these areas of stress concentration can lead to fracture of this crown. The fit of a traditional porcelain jacket crown to the underlying tooth structure is always a compromise. Since the porcelain is fired to a 0.001 inch thickness platinum foil, when the platinum foil is removed prior to cementation, a space is created which always results in a loose fitting crown. The deficiencies of fit are further aggravated by the continual shrinkage of the porcelain which occurs with each firing in the furnace.

Recently, a machinable glass-ceramic has been developed which utilizes a new technology to produce esthetic crowns. The new technology is based upon the use of tetrasilicic-mica glass based on a simple quaternary system, K_2O-MgF_2-MgO-SiO_2. Glasses in this system may be melted at 1380 degrees C. and can be formed into dental crowns by utilizing conventional lost-wax technique, investing in conventional phosphate bonded investment, and then cast with a centrifugal casting machine and a resistance heated melting chamber. By reheating the resultant castings at a ceraming temperature of 1075 degrees C. for a period of six hours, a uniform dispersion of randomly oriented tetrasilicic-mica crystals is produced. The name "tetrasilicic" is derived from the crystal chemistry of the precipitated mica crystals, which are SiO_4 tetrahedra. The most unique feature of the mica-glass ceramic is that it can be machined and finished using conventional dental rotary instruments. The machinability results from the fact that fracture paths follow either the mica cleavage planes or the mica-glass interfaces. Fracture propagation along the basal planes of mica is very difficult. Therefore, as the crystals become larger and longer (up to a critical plate diameter), they also serve the important role of reinforcing the material by arresting crack propagation. The mechanical properties of the castable ceramic material show it to have a Knoop hardness of 290 (which is similar to dental enamel) and a modulus of rupture of approximately 2 times that of enamel and 3 times that of dental porcelain.

It would appear that this new material offers certain potential advantages. The ceramic crown can be waxed, invested, cast, and finished utilizing the same technology as is currently used with metallic crowns. Hence, the time involved for fabrication and the technical skill required should be significantly less than the traditional porcelain jacket crown technique. Since the crown is produced from a homogeneous melt, there should be minimal possibility for the development of internal voids and weakening of the crown. Additionally, when the casting is first produced it is transparent and internal voids can be easily detected. A platinum matrix is not used. Consequently, it should theoretically be possible to get an improved fit of the crown to the prepared tooth structure.

It must be recognized that the new crown will be cast in one homogeneous unit. Therefore, the crown will be initially monochromatic and lack the different colors present in the gingival, body and incisal portion of a natural tooth. To chieve a natural lifelike appearance, surface stains must be fired to crowns, and hopefully, they become an integral durable part of the crown. This research project was conducted to evaluate the clinical performance of this new ceramic material with special emphasis upon the esthetic qualities which surface staining imparts to the porcelain crown, the permanence of the stain and glaze, the fit of the restoration, and other performance parameters.

2. DESCRIPTION OF THE EXPERIMENTAL METHOD TO ASSESS CLINICAL PERFORMANCE

The objective of this study was to evaluate the clinical performance of a new castable ceramic material for use in fixed prosthodontics. Particular emphasis was placed upon the incidence of fracture, fit, and esthetic qualities of the restoration, and permanence of the superficial stain and glaze. Assessment was based upon the placement and evaluation of 40 anterior and 40 posterior full veneer porcelain jacket crowns for a period of three (3) years.

We were concerned with the selection of an appropriate control for this study. We considered using porcelain jacket crowns. However, the use of porcelain jacket crowns is decreasing in favor of porcelain-fused-to-metal restorations. Therefore, we felt that the castable ceramic material should be compared to the material for which it might be considered a viable alternative. Accordingly, we placed an additional 20 control Ceramco veneered PFM restorations in the same patients as the test castable ceramic material.

The patient population consisted of adult male and female patients who were previous participants in the clinical dental research program. The majority of these individuals were retired military personnel and their dependents, and federal civil service employees who resided in the San Francisco Bay area. Priority was given to those patients who on the basis of their participation in previous clinical studies, had a positive history of reliability for keeping their annual recall examination appointments.

Within this group of patients, the following criteria were used for selection of candidate restorations:

1. Each patient had to possess one or more teeth which required single unit full coverage porcelain veneer crowns. No more than two (2) individual crowns involving either anterior and posterior teeth were placed in the same patient.

2. The individual tooth's anatomy, angulation, and occlusal relationship assured that the tooth preparation procedures could be accomplished without endangering the vitality of the pulp. Teeth requiring endodontic treatment were excluded from the study.

3. The periodontium of each tooth was non-inflammatory, had a pocket depth of less than 4mm, had osseous support of no less than 2/3 of root length; and had a mobility no more than a grade II.

4. Teeth which did not meet the above requirements were be excluded from the study.

When possible, study casts were taken prior to the tooth preparation procedures. These diagnostic casts provided a guide for anatomical form, occlusion, and for the fabrication of customized temporary restorations. Teeth which were carious or lacked adequate occlusal height were restored with self-threaded pins and tooth colored composite resin.

Since esthetic acceptability of the final restoration was one of the major objectives of this study, shade determination for each restoration was made by the concurrent agreement of two (2) dentists. The shade selection was made with the use of a Bioform shade guide and the procedure was performed prior to tooth preparation procedures and under the same ambient lighting conditions used for subsequent esthetic acceptability determinations.

The tooth preparation was performed utilizing currently accepted full porcelain veneer preparation principles. Specific attention was given to: creating flat planes at 90 degree angles to occlusal forces, rounding sharp angles to reduce stress concentration, conservation of tooth structure to provide support for the crown, and uniform reduction to provide bulk to the crown walls. The teeth were reduced to provide a minimum of one millimeter crown wall thickness. The preparation ended in a gingival shoulder with an internal rounded line angle. Tooth reduction was performed with tapered round ended diamond points. Hand planing of the gingival shoulder was performed when needed. The gingival shoulder was placed subgingivally, if esthetics or mechanical factors required it. However, attempts were made to place the lingual margins supra-gingivally, both for ease of assessing marginal fit and for periodontal considerations.

Retraction of the gingiva and design of the temporary restoration were accomplished with care to avoid unusual gingival trauma. The exposed dentin was coated with a copal varnish. Full arch impressions were taken utilizing stock disposable trays. The manufacturer's directions were observed regarding the handling of the impression material.

The same brand of polyvinylsiloxane impression material was used throughout the study. Impressions were allowed to set for 12 hours and poured utilizing an improved stone with the manufacturer's recommended powder/water ratio. Temporary crowns were fabricated utilizing Ion crown forms, Snap acrylic resin and then cemented with Temp-bond. Particular attention was given to obtaining correct gingival extension, marginal adaptation and occlusion.

Every attempt was be made to minimize the period of time elapsed following preparation and impressions to the delivery of the final restoration. The cast crowns were trial seated on the prepared teeth and the anatomical outline form and correct occlusal and interproximal relationships with the adjacent and opposing dentition were established. At the same appointment visit, our own research technician stained and glazed the crowns according to instructions provided by the manufacturer. The crowns were not veneered with porcelain and only superficial stain and glaze was utilized to achieve esthetic compatibility with adjacent teeth. In the event (due to unusual tooth colorations or other factors), we found it impossible to achieve clinically acceptable esthetic results with the castable ceramic material, then a conventional porcelain fused to metal restoration was substituted. The factors responsible were be fully documented.

If minor occlusal adjustments were necessary after glazing and prior to final cementation, rather than reglaze the crowns, they were repolished with fine abrasive rubber wheels. Premature fracture of the castable ceramic crowns may be related to inadequate occlusal reduction or other operator manipulative factors. In order to gain information relative to the influence of these operative factors upon clinical performance, thickness measurements in selected areas of the crowns were made. These measurements were made after all occlusal adjustments were completed and immediately prior to cementation with the manufacturer's proprietary shaded zinc phosphate cement.

All laboratory procedures were performed at this facility by our research staff under controlled conditions. The impressions were poured in Die Keen improved dental stone. The manufacturer's water/powder ratio was followed and the resulting full arch master cast were articulated with opposing models. The Pindex system was utilized to provide removable dies of the prepared teeth. These dies received two coats of the manufacturer's proprietary shaded die spacer. This coating would ensure that small irregularities on the surface of the dies would not interfere with seating of the castings and adequate room would be allowed for the cement film thickness. Care was taken to leave the gingival shoulder uncoated.

The sectioned and articulated casts were sent to Corning for fabrication of the castable ceramic crowns. The crowns were then returned to our laboratory where, after adjustment for shape, contour, interproximal contact and occlusion by the clinician, the crowns were stained and glazed according to directions to be provided by Corning. The original diagnostic and prepared tooth casts along with the specifics of the staining and glazing procedure for each restoration were recorded and stored for later reference. Records were maintained of the batch numbers of all materials, such as impression materials, cements, dental stone, etc. used in the study.

It is well know that use of certain topical fluorides may produce etching of porcelain glazes. Therefore, patients selected for use in this study were advised of this possibility and cautioned not to have the test and control porcelain restorations treated with topical fluoride solutions or gels.

CLINICAL EVALUATION Each crown was considered an experimental unit. The crowns were evaluated one week after cementation (base-line evaluation), six months later, and then on an annual basis for 3 additional years. In the event of failure, the crown was replaced with a porcelain-fused-to-metal restoration.

Evaluations were performed by two dentists utilizing criteria based upon an ordinal rating system as described in the Table 19. Each examiner's rating was performed without knowledge of the other examiner's evaluation. These ratings were entered directly into our clinical computer. The computer was programmed to determine whether both examiners agreed with each other. In the event of a disagreement the computer would call the specific area of disagreement to the attention of both examiners, so that a consensus rating could be decided. At each examination interval the incidence of failures and reasons for replacement of any restoration were also recorded.

The criteria shown in Table 20 were utilized to assure that the crowns were evaluated in a standardized manner. An independent team of examiners at Corning utilized these criteria to assess the extent to which the submitted preparations conformed with the *tentatively* established castable ceramic crown preparation guidelines. If there were obvious deficiencies in the preparation, the casts were returned to the operator for modification.

Table 19

CRITERIA FOR CLINICAL EVALUATION OF CASTABLE CERAMIC CROWNS

1. *Marginal Adaptation:*
   - A - No catch or penetration as explorer is moved either from tooth to crown or from crown to tooth.
   - B - Explorer catches only when moved from crown to tooth, i.e., crown margin is well adapted but short.
   - C - Explorer catches when moved from tooth to crown, i.e., crown margin is well adapted but over extended.
   - D - Explorer is able to penetrate discrepancy between crown and tooth, i.e., marginal adaptation is defective.

2. *Esthetic Acceptability:*
   - A - Overall shade of crown is comparable to adjacent teeth and is within the acceptable shade range for the patient.
   - B - Shade of the body and incisal areas are comparable to adjacent teeth and within the shade range for the patient, but, the gingival third is outside the acceptable range.
   - C - Overall shade of the crown is not comparable to adjacent teeth or the shade range for the patient.

3. *Surface Character of Glaze and Stain:*
   - A - When viewed under dry conditions, the entire surface of the crown has a high luster.
   - B - Portions of the crown have lost their high luster and/or underlying color.
   - C - The entire crown has lost its surface luster and the underlying color may be also lost.

4. *Tissue Compatibility:*
   - A - No evidence of inflammation of the gingival tissue in contact with the crown.
   - B - Slight to moderate inflammation and/or edema of the gingival tissue in contact with the crown.
   - C - Severe inflammation and/or edema of the gingival tissue in contact with the crown.

5. *Opposing Dentition:*
   - A - Natural dentition.
   - B - Metallic restoration.
   - C - Porcelain restoration.
   - D - Resin restoration.
   - E - Edentulous area.

Table 20

CRITERIA FOR LABORATORY EVALUATION OF CASTABLE CERAMIC CROWN PREPARATIONS

1. Margins: Margins should be well defined, smooth and of adequate thickness to ensure that the restoration will have sufficient strength in these areas to minimize the possibility of fracture and leakage.
   A - The margin is either a shoulder or a heavy chamfer of a depth of 1.0mm.
   B - The margin is either a shoulder or a heavy chamfer of a depth of 0.5mm.
   C - The margin exhibits areas that are not smooth, but meet the requirements of A or B.
   D - There are ill-defined marginal areas.

2. *Occlusal Reduction:* Adequate occlusal reductions should be present to ensure reproduction of occlusal anatomy at a uniform thickness sufficient to resist the forces of mastication.
   A - Reduction of 2.0mm or greater.
   B - Reduction of 1.4 - 1.9mm.
   C - Reduction of 1.3mm.
   D - Reduction of less than 1.3mm.

3. *Wall Thickness:* There should be sufficient axial reduction to achieve adequate esthetics and strength of the final restoration.
   A - Lingual and interproximal reduction of 1.0mm or greater and labial reduction of 1.25mm or greater.
   D - Less reduction than the above.

4. *Taper:* The axial preparation should be non-parallel and not undercut in order to draw an undistorted wax pattern and achieve a passive fit of the final restoration with adequate retention.
   A - Adequate taper to meet the above.
   D - Parallel, undercut, or excessive taper to axial walls.

5. *Line Angles:* All internal line angles should be rounded to minimize areas of stress concentration in the final restoration.
   A - All line angles are rounded.
   B - Some line angles are rounded.
   D - All line angles are sharp.

6. *Occlusal Height:* There should be adequate occlusal height to ensure retention and Height minimize the development of torquing occlusal stresses.
   A - Adequate height.
   D - Inadequate height.

For demonstration and documentation purposes, 35 mm transparency photographs were taken of selected restorations at base-line and at each recall period. In order to document the permanence or any changes in the surface glaze of the crowns, a 1.0 mm circular area of glaze was removed from the crown. This was accomplished by means of a appropriate mask with a 1.0 mm diameter hole. When placed on the surface of the crown the mask exposed a circumscribed area of glaze. The glaze in this limited area was removed with aluminum oxide air abrasive. This small circular area in which the glaze had been removed was placed in an esthetically non-critical area of a number of the crowns. A polyvinysiloxane impression of this area was taken at base-line and at every subsequent evaluation period. The circular area served as a fiducial reference point from which any changes in the surface glaze in the immediate vicinity was documented and assessed by scanning electron microscopy.

As detailed in the appendix, the evaluation criteria focused upon esthetic acceptability, marginal adaptation, tissue tolerance, and permanence of the surface stain and glaze. In the event a restoration required replacement, the reasons for replacement were categorized and recorded.

PILOT STUDY: It is reasonable to assume that the laboratory and clinical manipulative factors which are unique to the new castable ceramic material play an important role in influencing the ultimate clinical performance of this material. As in the application of any new technology, there is a learning process that must be addressed before the new technology itself can be effectively assessed. In this particular application, the research laboratory technician must become adept at applying the superficial stain and glaze to achieve a predictable level of esthetic realism. In a similar manner, the clinical staff must also become familiar with occlusal adjustment and placement procedures unique to this particular material. In view of these important considerations, the assessment of the previously mentioned 80 castable ceramic restorations was preceded by a preclinical phase of the study.

In the preclinical study our research laboratory technician received individual training from Corning to assure proper application of the stain and glaze. After his training was completed, and our professional staff had an opportunity to gain experience with the material and related technique by placing 10 anterior and 10 posterior castable ceramic restorations.

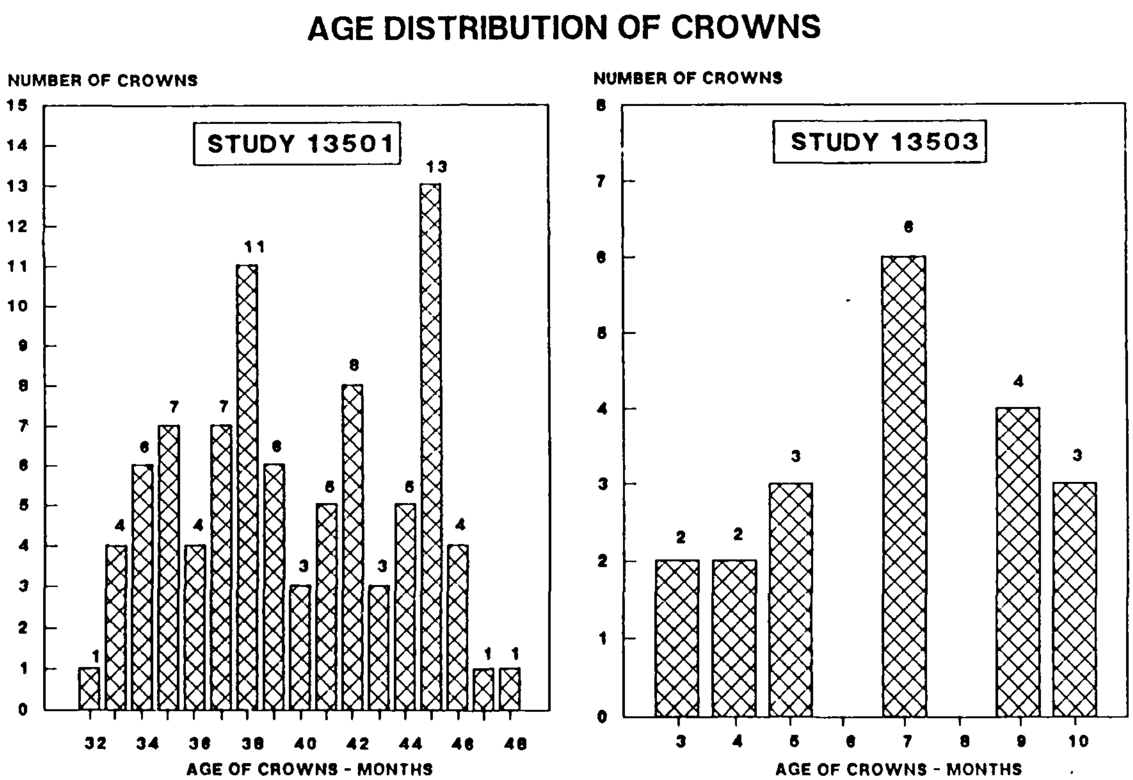
3. THE CLINICAL PERFORMANCE OF THE CASTABLE CERAMIC MATERIAL

This report will present the results of a three year clinical study (Study 13501) to assess the performance of a castable ceramic material intended for use in dental fixed prosthodontics and to determine the operational parameters required for successful clinical function. This report will also present the results of a second study (Study 13503) of one year duration of this same restorative material, which was limited to the restoration of molar teeth and strictly adhered to the guidelines which were suggested by the first study.

All the restorations for the first three year study were placed by two operators, Dr. James A. Ellison and Dr. Armand A. Lugassy. The restorations for the second study which was limited to the restoration of molar teeth, were placed solely by Dr. Lugassy. The restorations were completed, base-line evaluations were performed, and the restorations were re-examined at 6 months, 1, 2, and 3 year intervals. The restorations were rated independently by Drs. J.P. Moffa and J.A. Ellison.

As illustrated in Figure 36, over a period of 17 months a total of 106 crowns associated with Study 13501 were placed in the oral cavities of 71 patients -- -- 63.4 percent were males and 36.6 percent were females. The mean age of this patient population was 52.4 years -- 76.1 percent were Caucasian, 11.3 percent were Asian, and the remainder represented other ethnic groups. At the time of this report, the mean age of all restorations which were placed in Study 13501 was 37.4 months.

Figure 36

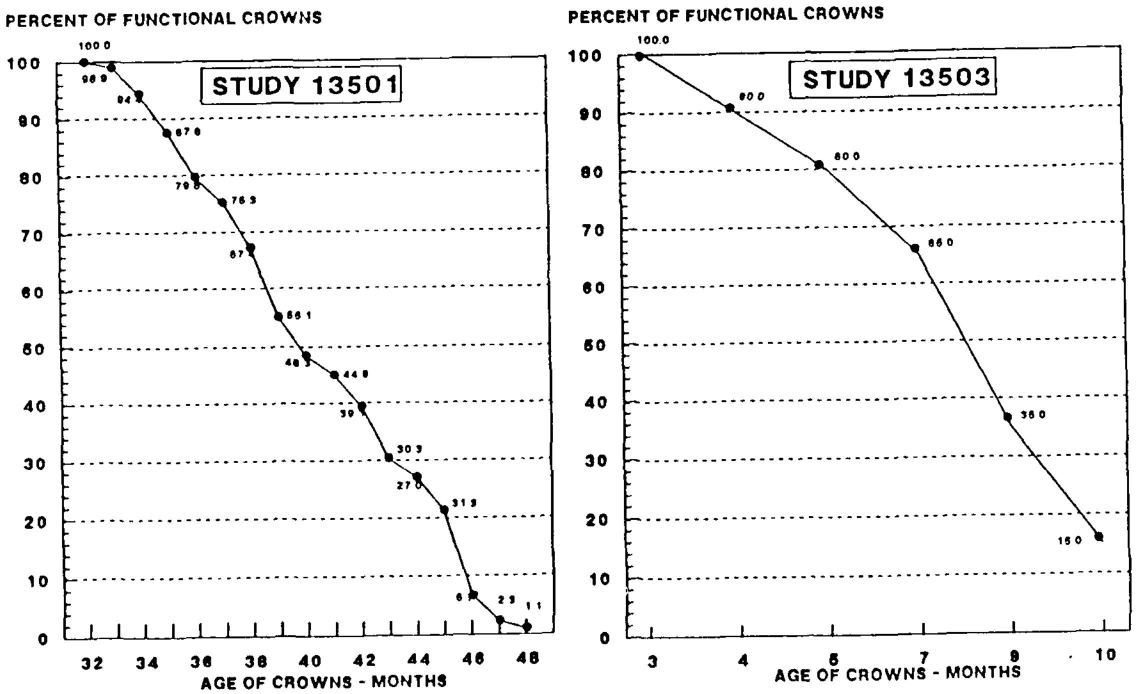


For the second limited molar Study 13503, over an 8 month period a total of 20 restorations were placed in the oral cavities of 20 patients - 75 percent were males and 25 percent were females. The mean age of this patient population was 50.5 years, of which 30 percent were Caucasian and the remainder represented other ethnic groups. At the time of this report, the mean age of all restorations which were placed in Study 13503 was 6.9 months.

The actual age distribution of functional crowns placed in both Study 13501 and Study 13503 is illustrated in Figure 37. Since the crowns in these two studies were placed over a period of 8-17 months, this report represents a diverse cross section of crown ages. The age of the crowns as a percentage of the total functional restorations is presented in Figure 37. These graphs show, for example, that 79.8 percent of the functional crowns in Study 13501 were 36 months of age or older. Similarly, for the more recent Study 13503, 80 percent of the functional crowns were between 4 and 10 months of age.

Figure 37

AGE OF CROWNS AS A PERCENTAGE OF TOTAL FUNCTIONAL RESTORATIONS



In view of its extensive nature, a history of the actual restorations placed in each patient may be found in Appendix 4 of this report. Each patient is identified by a six digit identification number. In addition, this table presents:

1. Patient's sex, race and age
2. Dimension of cast ceramic crown at 6 locations
3. Date of placement
4. Tooth number
5. Identification of the restorative material:
   a. cast ceramic crown
   b. PFM Control crown
6. Identity of dentist
7. Evaluation codes or codes of reasons for non-evaluation at:
   a. base-line
   b. 6 months
   c. yearly intervals, 1-5
8. Age of restoration at time of report or at time of replacement
9. If replaced, the date of replacement

The distribution of the control PFM restoration and the test cast ceramic crowns for Studies 13501 and 13503 for each tooth in the patients' arch may be found in Table 21. For Study 13501, 36.3 percent of the restorations were placed in anterior teeth. Only one restoration was a mandibular central incisor and the remainder were maxillary central and lateral incisors. In Study 13501, 79.4 percent of the premolars were in the maxillary arch and 21.2 percent of the crowns were placed in molar teeth. Molar crowns were similarly distributed between the maxillary and mandibular arches. Ninety-four percent of molar crowns were pl--ced in first molar teeth.

Table 21

DISTRIBUTION OF RESTORATIONS PER TOOTH

MAX. TOOTH NOS.	PFM	CAST CERAM 13501	CAST CERAM 13503	MAND. TOOTH NOS.	PFM	CAST CERAM 13501	CAST CERAM 13503
1				17			
2			1	18			
3	2	4	1	19	3	3	5
4	3	9		20		4	
5	1	5		21		2	
6				22			
7	1	8		23			
8	2	7		24			
9	2	9		25	1		
10	1	5		26			
11	1			27			
12	2	3		28	2		
13	2	10		29	2	1	
14	1	5	3	30		4	10
15				31		1	
16				32			

	ANTERIOR	PREMOLAR	MOLAR	TOTAL
PFM	8	12	6	26
CAST CERAM 13501	29	34	17	80
CAST CERAM 13503	0	0	20	20

Immediately before cementation, measurements with a dial micrometer to an accuracy of 0.1mm were made of the crowns in eight locations. A summary of the descriptive statistical analysis of the anterior and posterior cast ceramic crowns for Studies 13501 and 13503 may be found in Table 22. The clinical crown preparation procedures for Study 13503 required an occlusal reduction of 1.7-2.0mm and a minimum wall thickness of 1.0mm. Comparison of the dimensions of the posterior crowns in the two studies shows a 42.1% increase of 2.7mm of the maximum functional area in the more restrictive Study 13503. Similarly, the minimum functional area was 1.9mm, a 63.2% increase. The dimensions of the lateral wall thickness was approximately 30 percent greater for Study 13503 than Study 13501. In addition, a comparison of the coefficient of variation (C.V.) of the two posterior crown studies reveals lower values for the recent Study 13503, which would indicate a more consistent crown preparation procedure.

Table 22

CROWN DIMENSIONS

	MEAN	S.D.	C.V.	Max.	Min.
ANTERIOR CROWNS - STUDY 13501					
Crown Length	9.1	0.7	8.6	10.5	8.0
Incical Edge, Minimum	1.2	0.3	27.2	1.9	0.8
Facial, Center	1.2	0.3	27.2	1.7	0.8
Lingual, Center	1.0	2.2	19.4	1.5	0.8
Mesial, Center	1.9	0.4	24.7	3.3	1.3
Distal, Center	1.6	0.3	20.7	2.3	1.0
Functional Area, Maximum	1.3	0.4	31.7	2.7	0.9
Functional Area, Minimum	1.0	0.4	38.6	2.5	0.8
POSTERIOR CROWNS - STUDY 13501					
Crown Length	7.2	1.2	17.1	10.0	5.2
Occlusal Pit, Min.	1.0	0.1	17.5	1.5	0.8
Facial, Center	1.2	0.3	27.7	2.4	0.8
Lingual, Center	1.2	0.3	25.4	2.0	0.8
Mesial, Center	1.8	0.4	22.0	3.3	1.1
Distal, Center	1.7	0.3	17.6	3.0	1.2
Functional Area, Maximum	1.9	0.4	22.5	3.5	1.5
Functional Area, Minimum	1.2	0.2	22.3	2.0	0.8
POSTERIOR CROWNS - STUDY 13503					
Crown Length	6.6	0.8	12.6	8.5	5.5
Occlusal Pit, Min.	1.5	0.2	12.9	1.9	1.2
Facial, Center	1.6	0.3	20.8	2.5	0.9
Lingual, Center	1.6	0.3	22.1	2.2	1.0
Mesial, Center	2.4	0.3	13.5	3.0	1.9
Distal, Center	2.2	0.3	14.0	2.7	1.7
Functional Area, Maximum	2.7	0.5	18.9	3.6	1.6
Functional Area, Minimum	1.9	0.3	17.3	3.0	1.5

Since the castable ceramic material was a unique new material, the minimal crown thickness and other clinical operational parameters were only tentatively established. Therefore, one of the objectives of this study was to determine the boundary clinical parameters required for successful clinical function. To achieve this goal, crowns were fabricated on preparations which did not meet all requirements of the tentative preparation guidelines for Study 13501.

The distribution of ratings and a summary of the five criteria for the control PFM and the cast ceramic materials, Nos. 13501 and 13503 may be found in Appendix 4. This distribution details the ratings for each of the five criteria at the base-line (Period #0), at the 6 month recall (Period #1), and at the 1-3 annual recall intervals (Periods #2-4). The distribution is divided into five (5) general sections. The first section deals with the distribution of ratings at the base-line and subsequent recall periods. Section two and three present the distribution and reasons why restorations were not evaluated (related and unrelated reasons). The fourth section reveals the reasons restorations were not evaluated due to patient complications. The fifth section is a summary of the previous sections. In this section the ratings at the later recall periods are compared to the ratings at base-line to determine whether the ratings improved, deteriorated, or exhibited no change. A summary of the distribution of ratings and the reasons for non-evaluation at the 6 month and annual recall periods may also be found in Appendix 4.

At the three year evaluation period, we were able to assess the clinical performance of 103 of the original 106 restorations which were placed in Study 13501. Therefore, the evaluation rate was 97.2 percent for this study. At the one year recall period, we were able to assess the clinical performance of 100 percent the original 20 restorations which were placed in Study 13503.

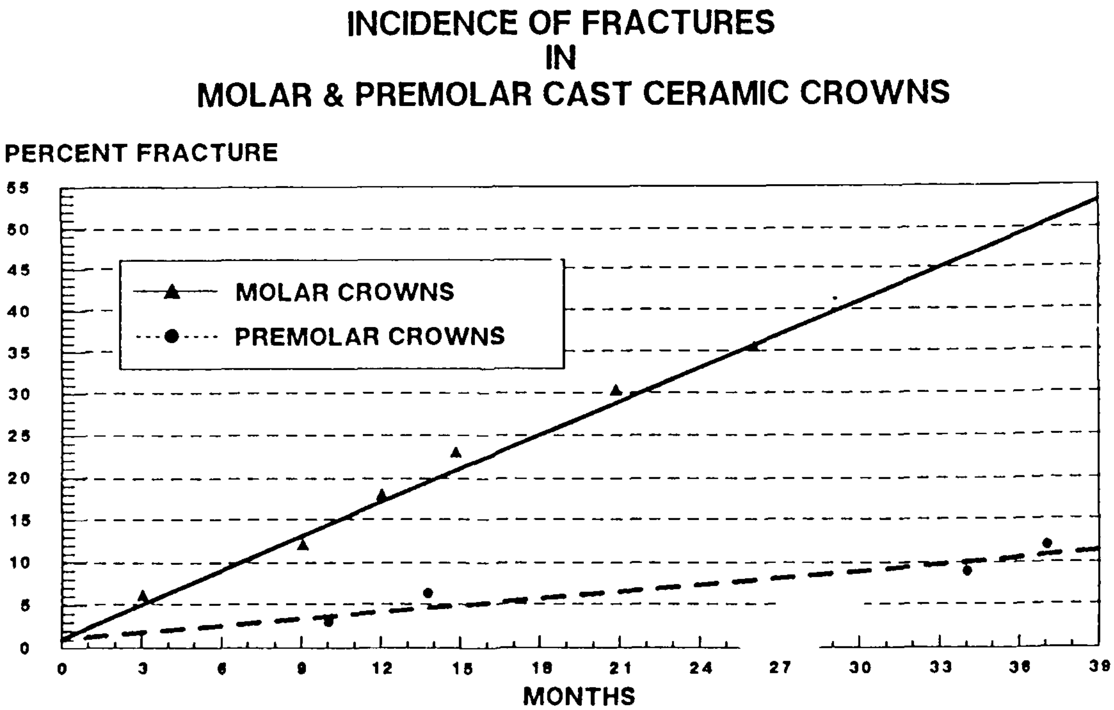
During the three year course of the Study 13501, five cast ceramic crowns and one PFM control crown were replaced due to reasons which were judged to be unrelated to the specific restorative materials. One control PFM crown required endodontic treatment for non-related reasons and was removed from the study. Two cast ceramic crowns fractured as a result of trauma to the patient's anterior teeth. Two additional cast ceramic crowns were replaced due to fracture of the underlying composite core build-up material. In addition, one cast ceramic crown was replaced due to the need for endodontics. Three cast ceramic crowns fractured during trial insertion and occlusal equilibration. These three fractures may be considered operator related because it was felt that the crowns were not completely seated or were slightly rotated during placement. When the crowns were refabricated and attention to the problems were addressed, the crowns were placed and cemented with no difficulties. During the one year assessment of the cast ceramic crowns in Study 13503, one crown dislodged during an unrelated impression taking procedure. The cement was removed from the internal surface of the crown and the crown was recemented and will continue to be observed.

RELATED REASONS A total of eleven (11) cast ceramic crowns required replacement during the 36 months of evaluation. One (1) additional cast ceramic crown required replacement at 38 months due to related reasons and is included in this report. A detailed summary of all failed CASTABLE CERAMIC crowns may also be found in Appendix 4.

Analysis of the reasons for replacement revealed that only one (1) maxillary second premolar crown failed because of caries at 31 months. The vast majority of the other failures (91 percent) were due to fracture of the cast ceramic material. The elapsed time before fracture ranged from 3 to 38 months with a mean time to fracture of 20 months. Six (6) of the eleven (11) fractures occurred in molars, 4 occurred in premolars, and there was only one (1) anterior crown fracture. The overall incidence of fracture for Study 13501 was 13.75 percent, of which 35.29 percent, 11.77 percent, and 3.45 percent represented the incidence of fracture for molars, premolars and anterior teeth, respectively.

To learn whether there was an orderly relationship between elapsed time and the incidence of fracture for molars and premolars, linear regression analysis was performed. Figure 38 illustrates the comparative incidences of the fracture in molar and premolar castable ceramic crowns. The correlation coefficients were 0.993 and 0.950 for molars and premolars, respectively. The linear regression equation for molars was: Percent Fracture = 1.319 X Time (Months) + 1.682. The regression equation for premolars was: Percent Fracture = 0.263 X Time (Months) + 1.103. It was apparent from the diverse slopes of these lines (1.319 vs. 0.263), that molar crowns had a very significantly higher fracture incidence than premolar crowns.

Figure 38



The relatively high correlation coefficients would indicate that in our clinical study, there appears to be a relationship between the age of the restorations and the incidence of fracture of molar and premolar crowns. An extensive analysis of the data in this study was performed to determine factors which might be responsible for this incidence of failure. The factors summarized in Appendix 4 are: the age of the restoration when it fractured; a clinical observation and description of the fracture; a summary of the Corning fractology report; and measurements of the finished crowns. In addition, an independent prosthodontist described and made measurements of the preparations and reviewed the patient's occlusion without prior knowledge of other fracture data.

Although there was a wide diversity of patients and associated findings, several factors appear to be common to the incidence of fracture. There was evidence that the failed restorations were subject to high occlusal loading, as shown by heavy wear facets on adjacent teeth and patient history of bruxism. Indeed, certain fractures in premolars occurred when these teeth were the terminal tooth in the arch and were functioning as molars. To further compound high stress effects, there were also isolated instances of shading porcelain on the internal aspects of crowns, excessive cement thickness and certain preparation deficiencies. A comparison of the preparation and crown dimensions revealed that the minimal functional occlusal dimensions of the final crowns were always less than the available space created by the crown preparation procedures. The dental anatomy created by the dental ceramist can significantly reduce the occlusal clearance dimensions and further aggravate the application of high stress to a reduced occlusal thickness.

Figure 39

DISTRIBUTION OF CROWN DIMENSIONS

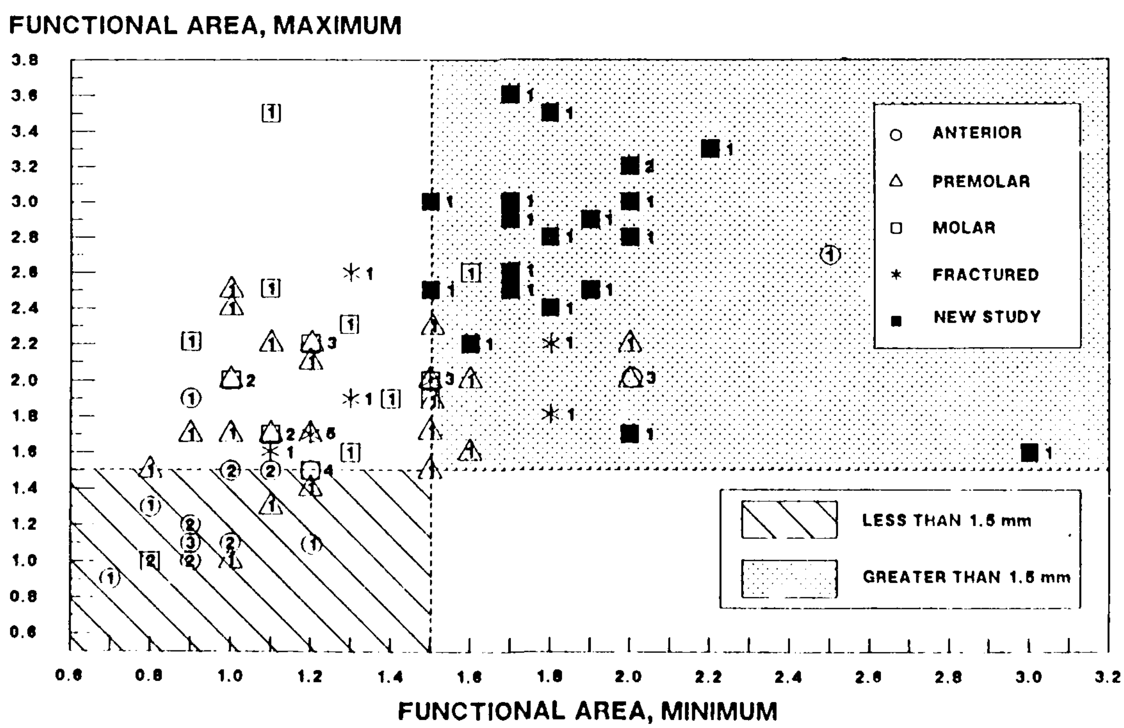


Figure 39 illustrates the distribution of the functional minimum and maximum crown dimensions among the anterior, premolar, molar and fractured crowns in Study 13501 and the new molar crowns in Study 13503. The upper right quadrant shaded area represents crowns with minimum and maximum dimension greater than 1.5mm, and it is clearly apparent that the molar crowns in new Study 13503 all fall within the recommended dimensions. In contrast, the lower left lined area represents crowns with functional maximum and minimum dimensions were less than the recommended 1.5 mm. It is most interesting to note that in spite of the fact that the majority of anterior crowns fell below the recommended 1.5mm thickness, there was only one incidence of fracture of anterior crowns. Similarly, there were no instances of fracture of premolars which fell within the less than 1.5mm functional thickness lower left quadrant. The absence of fractures in this quadrant is supported by the fact that in comparison to molars, anterior and premolar teeth are subjected to lower occlusal forces.

The question which we attempted to address was whether it was possible to predict the success of the final cast ceramic restoration solely on the basis of the crown and preparation dimensions. Accordingly, on a blind basis we made certain measurements of all the premolar and molar preparations involved in Studies 13501 and 13503. These measurements included the occlusal thickness, wall thickness (4 walls), margin thickness, crown height, and preparation height. Since it was conceivable that a difference between the crown height and preparation height could result in adverse torque type stress, we also calculated the crown/preparation ratio. After the measurements were made, they were divided into those that represented fractured, non-fractured, and restorations involved in the new molar Study 13503. A summary of the data may be found and graphically illustrated in Figure 40. The mean values were subjected to a Student's "t" Test and the results of the statistical analysis may also be found on this same page.

Analysis of this data revealed that measurement of the occlusal, wall, and margin thickness dimensions was not capable of discerning statistical significant differences between fractured and non-fractured cast ceramic restorations. Similarly, measurement of the crown/preparation ratios, did not show any statistically significant differences between restorations which fractured and those that did not fracture. In view of the tighter crown preparation and occlusion constraints of the new molar Study 13503, there were very significant statistical differences between the occlusal, wall and marginal thickness measurements of these Study 13503 restorations and the non-fractured crowns involved in the previous STUDY 13501. It would appear that where high occlusal loading is operational, such as in molars, in the presence of bruxism or other abnormal occlusal function, reduced crown thickness can lead to an increased incidence of fracture. Support for this hypothesis is provided by the current absence of any fractures in Study 13503, in which crown dimensions and occlusal relationships were carefully controlled.

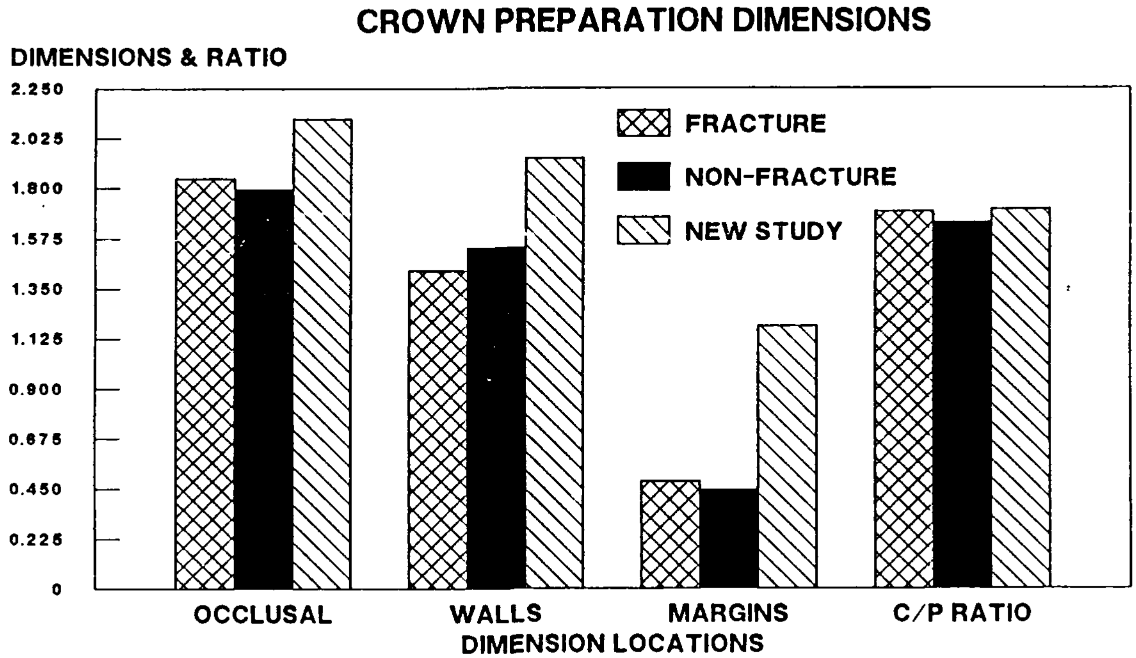


Figure 40

LOCATION	FRACTURE MEAN	FRACTURE C.V.	NON-FRACTURE MEAN	NON-FRACTURE C.V.	NEW STUDY MEAN	NEW STUDY C.V.
Occlusal Thickness	1.84	13.4	1.79	15.4	2.11	12.1
Wall Thickness	1.43	14.8	1.53	14.7	1.93	11.4
Margin Thickness	0.48	13.7	0.44	18.7	1.18	14.0
Crown Height	4.64	14.8	4.72	14.5	5.13	9.17
Preparation Height	2.81	23.5	2.93	20.3	3.01	11.8
Crown/Prep. Ratio	1.69	12.5	1.64	10.7	1.70	6.0

COMPARISON	t-VALUE	STATISTICAL SIGNIFICANCE
Occlusal Thickness, Fract vs Non-Fract	0.5216	Not Significant
Occlusal Thickness, Non-Fract vs New Study	4.3333	Sig. (<0.0001)
Wall Thickness, Fract vs Non-Fract	1.3030	Not Significant
Wall Thickness, Non-Fract vs New Study	6.2396	Sig. (<0.0001)
Margin Thickness, Fract vs Non-Fract	1.4062	Not Significant
Margin Thickness, Non-Fract vs New Study	18.2375	Sig. (<0.0001)
Crown/Prep Ratio, Fract vs Non-Fract	0.7293	Not Significant
Crown/Prep Ratio, Non-Fract vs New Study	1.8743	Not Significant

STUDY 13503 OBSERVATIONS In view of the increased occlusal, lateral and marginal tooth reductions associated with Study 13503, there are certain additional considerations which should be included in this report. We found that case selection should be dependent upon age of the patient, size of the pulp chamber, and position, shape and size of the tooth. In this connection, analysis of the radiographs is essential to determine size of the pulp, presence of prominent pulp horns and other pulp chamber abnormalities. Attention to the possibility of pulp exposure is particularly important when a substantial amount of tooth structure is removed. Hence, the recommended molar preparations used in this study would be better suited to older patients with reduced pulp dimension.

Of the 20 crowns which were placed in the 20 patients involved in Study 13503, there were 9 patients who experienced hyperemia, as evidenced by post-operative sensitivity to either cold or sensitivity on biting hard foods, i.e. 45 percent. Of these 9 patients, 3 of them resolved before 6 months; the 6 crowns have not resolved to-date. In contrast, in the previous Study 13501, only 2 of a total of 71 patients experienced symptoms of a transient hyperemia, i.e. 2.8 percent. There were a number of factors associated with the new Study 13503 which may have accounted for the increased incidence of hyperemia. Since extreme care was exercised by the prosthodontist to achieve an "ideal" crown preparation, take photographs of all aspects of the clinical procedure and perform other study procedures, there was an estimated 25 to 50 percent increase in the time normally required to complete the operative procedures. In addition, since all aspects of the laboratory work were performed at a remote site (Corning Glass Works research laboratory), the patients were required to retain the temporary crowns for a longer period. Both extended preparation time and period of temporization could contribute to an increased incidence of transient hyperemia.

We did find that the requirements of increased occlusal reduction created problems of achieving adequate crown preparation height and retention. Todate we have experienced one case of loss of a cemented cast ceramic crown during a subsequent impression taking procedure. Since supplemental retention aids such as pins and grooves are not compatible with this restorative material, use of this material is restricted to crowns with adequate occluso-gingival height. In addition, furcas, bifurcation, trifurcations, and other root invaginations makes it difficult to achieve uniform shoulder preparations in these instances. There was excellent patient acceptance of the esthetics and function of the final restoration.

STUDY 13501 OBSERVATIONS At the third year recall period, there was an absence of any evidence of tissue incompatibility in that we could not detect any difference in the gingival response of the cast ceramic material and the PFM control.

In order to determine the permanence of the superficial shading porcelain, an intentional circular defect (1.0mm) was created with an aluminum oxide air abrasive and replicas were taken of the surface at base-line and subsequent recall periods. Examination of the circular fiducial markings and the surrounding porcelain by scanning electron examination revealed that there was no change from the base-line examination. The relative wear rate of the cast ceramic and PFM Control crowns and adjacent and opposing unrestored natural teeth is being studied by a replica technique. Examination and quantification is being performed by Dr. Ralph DeLong at the University of Minnesota, School of Dentistry.

In regard to esthetic acceptability, the relatively high translucency of the cast ceramic material and its unique ability to pick up adjacent tooth structure shades are distinctive advantages. Our laboratory technician experienced no difficulty in mastering the application of the shading porcelain. In the event of a shade mismatch, the ability to readily remove the shading porcelain with aluminum oxide air abrasive and reapply the shading porcelain is a valuable asset. The response of our patient population to the esthetics of the cemented restorations has been universally excellent.

In regard to marginal adaptation, 95 percent of the cast ceramic crowns were in either the alpha or bravo category as compared to 58 percent for the PFM Control crowns, at the end of the third year recall period. The ability to achieve a high degree of marginal adaptation and the elimination of any visible metal allows the placement of esthetic supragingival facial margins, a unique advantage of this material.

CONCLUSIONS A three year controlled clinical study was conducted of the performance of a castable ceramic material which was intended for use in fixed prosthodontics. On the basis of the clinical data collected, this material was extremely esthetic, possessed excellent marginal fit, biocompatibility, and there was no degradation of the superficial shading porcelain over the periods of observation involved in the two clinical studies.

An analysis of these two related studies revealed that control of clinical and laboratory parameters had a significant effect upon the successful clinical function of this new esthetic fixed prosthodontic material. Control of the thickness of the castable ceramic crown was a very important factor, especially under conditions of high occlusal loading.

IV. PUBLICATIONS

1. PUBLICATIONS SUPPORTED BY FUNDING FROM MRDC

1. Moffa, J.P., Lugassy, A.A., and Ellison, J.A.: Clinical evaluation of a castable ceramic material. Three year study. Abstract No 43, J. Dent Res. 67:188, 1988.

2. Moffa, J.P. and Ellison, J.A.: Clinical evaluation of an experimental hydrophobic and a proprietary composite resin. Abstract No. 59, J. Dent Res. 67:120, 1988.

3. Roberts, M.W., Folio, J., Moffa, J.P., and Guckes, A.D.: Composite resin/Dentin bonding agent for restoration of permanent posterior teeth. Abstract No. 64, J. Dent. Res. 67:120, 1988.

4. Lugassy, A.A., Moffa, J.P., and Ellison, J.A.: Relationship of marginal and occlusal wear of posterior composites. Abstract No. 1997, J. Dent. Res. 67:362, 1988.

5. Lugassy, A.A., Moffa, J.P., and Ellison, J.A.: Cast glass ceramic crowns: A one year clinical study. CDA Journal 14:72-11, 1986.

6. Moffa, J.P. and Lugassy, A.A.: Calibration of evaluators utilizing the M-L occlusal loss scale. Abstract No. 1197, J. Dent. Res. 65:120, 1986.

7. Moffa, J.P., Lugassy, A.A., and Ellison J.A.: Clinical evaluation of a castable ceramic material. Abstract No. 1564, J. Dent. Res. 65:135, 1986.

8. Poremba, E.P., Janis, J., and Lugassy, A.A.: A resin bonded conventional bridge combination: A case report. CDA Journal 13:41-44, 1985.

9. Roberts, M.W., Moffa, J.P., and Broring, C.L.: Two year clinical evaluation of a proprietary resin for the restoration of primary teeth. J. Ped. Den. 7:14-18, 1985.

10. Lugassy, A.A., and Moffa, J.P.: Laboratory model for the quantification of clinical occlusal wear. Abstract No. 63, J. Dent. Res. 64:181, 1985.

11. Moffa, J.P. and Watanabe, L.G.: Quantification of centrifugal casting parameters. Abstract No. 1588, J. Dent. Res. 64:351, 1985.

12. Moffa, J.P., Jenkins. W.A., Ellison, J.A., and Hamilton, J.C.: A clinical evaluation of two base metal alloys and a gold alloy for use in fixed prosthodontics: A five year study. J. Prosthet. Dent. 52:491-500, 1984.

13. Moffa, J.P.: Biocompatibility of nickel based alloys. CDA Journal 58:45-51, 1984.

14. Moffa, J.P., Jenkins, W.A., Ellison, J.A., and Hamilton, J.C.: A clinical evaluation of two base-metal alloys and a gold alloy for use in fixed prosthodontics: A five-year study. J. Prosthet. Den. 52:491-500, 1984.

15. Moffa, J.P., Jenkins, W.A., and Hamilton, J.C.: The longevity of composite resins for the restoration of posterior teeth. Abstract No. 253, J. Dent. Res. 63:199, 1984.

16. Moffa, J.P., Lorton, J.A., Ellison,J.A., and Vandre, R.H.: Comparison of the power of binary versus continuous range sort in clinical evaluation. Abstract No. 1487, J. Dent. Res. 63:336, 1984.

17. Roberts, M.W., Moffa, J.P., and Broring, C.L.: Two year clinical evaluation of a composite resin in primary molars. Abstract No. 1499, J. Dent. Res. 63:337, 1984.

18. Moffa, J.P.: Alternative dental casting alloys. Dent. Clin. North Am. 27:733-746, 1983.

19. Hamilton, J.C., Moffa, J.P., Ellison, J.A., Jenkins, W.A.: Marginal fracture not a predictor of longevity for two dental amalgam alloys. A ten year study. J. Prosthet. Den. 50:200, 1983.

20. Moffa, J.P., Ellison, J.E., and Hamilton, J.C.: Incidence of nickel sensitivity in dental patients. Abstract No. 271, J. Dent. Res. 62:199, 1983.

21. Lugassy, A.A., Moffa, J.P., and Watanabe,L.: Study of the creep rate of ceramo-alloys. Abstract No. 1056, J. Dent. Res. 62:286, 1983.

22. Imagawa, K., Lugassy, A.A., and Yee, F.S.: Comparative assessment of gravimetric densities of thermoplastic gutta-percha endodontic fillings. Abstract No. 45, J. Dent. Res. 62:174, 1983.

2. *PENDING PUBLICATIONS*

1. Moffa, J.P.: Porcelain materials. Accepted for publication in Advances in Dental Research - Galley proofs reviewed.

2. Moffa, J.P.: Comparative performance of amalgam and composite resin restorations and criteria for their use. Accepted for publication in Quintessence - Galley proofs reviewed.

4. Moffa, J.P. and Lugassy, A.A.: Quantification of clinical occlusal wear. Submitted for publication in the Journal of Dental Research.

5. Moffa, J.P. and Watanabe, L.G.: Quantification of centrifugal casting parameters. Submitted for publication in the Journal of Dental Research.

6. Moffa, J.P. and Ellison, J.A.: Long term clinical performance of composite resins for the restoration of posterior teeth. Submitted for publication in the Journal of the American Dental Association.

7. Moffa, J.P., Lugassy, A.A., and Ellison, J.A.: Clinical performance of castable ceramic material for fixed prosthodontics. A three year study. Submitted for publication in the Journal of Prosthetic Dentistry.

8. Roberts, M.W., Folio, J., Moffa, J.P., and Guckes, A.D.: Clinical evaluation of a composite resin/resin bonding agent for restoration of permanent posterior teeth. Submitted to the Journal of Prosthetic Dentistry.

3. MANUSCRIPTS IN PROGRESS

1. Moffa, J.P.: The correlation between the short term observations of the clinical performance and long term survival function of dental restorative materials.

2. Moffa, J.P.: The long term longevity and the modes of failure of anterior and posterior composite resin restorative materials.

3. Moffa, J.P.: The long term longevity and the modes of failure of amalgam alloy restorations.

4. Moffa. J.P.: The effects of polishing upon the long term longevity and the modes of failure of high and low copper amalgam alloys.

5. Moffa, J.P.: The long term longevity and the modes of failure of gold and base metal alloys.

6. Moffa, J.P.: A comparison the the long term longevity and the modes of failure of amalgam alloys and posterior composite resin restorative materials.

APPENDIX 1

MATERIALS = ALL COMPOSITE RESINS

CODES = 10103 10104 10801 10802 10901 11001 11402 10502 12201 12202 10102 10601 10803 10804 10805 10806 11401 11403 11404 12302 12303 12501 12502

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
1	1	3	1	-	1	-	-	1	15	1	3	2	3	5	7	172	215	13.7
2	14	7	10	12	5	-	1	-	18	1	3	1	3	7	4	88	174	11.1
3	17	7	8	5	-	-	-	-	13	12	2	-	6	9	-	95	174	11.1
4	38	12	5	8	4	8	-	-	3	2	4	1	1	-	6	179	271	17.3
5	26	9	3	3	5	3	-	1	6	1	4	-	4	2	19	131	217	13.8
6	6	2	-	-	-	-	-	-	-	1	-	-	1	-	2	48	60	3.8
7	11	2	-	-	2	2	-	-	1	1	1	-	1	3	6	45	75	4.8
8	8	1	-	-	4	10	-	-	-	2	2	-	1	1	3	59	91	5.8
9	2	2	-	-	5	4	-	-	-	1	1	-	-	2	2	71	90	5.7
10	3	-	-	1	2	1	-	1	-	-	-	-	2	-	1	61	72	4.6
11	2	1	-	-	1	-	-	-	-	-	-	-	-	-	1	11	16	1.0
12	1	-	-	-	-	-	-	-	-	-	-	-	-	1	2	29	33	2.1
13	4	-	-	-	1	3	-	-	-	-	-	-	-	-	-	6	14	0.9
14	-	2	-	-	-	1	-	-	-	-	-	-	-	-	1	17	21	1.3
15	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	37	39	2.5
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	1	-	-	-	-	-	-	-	-	-	5	1	7	0.4
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	133	48	28	29	32	32	1	3	56	22	20	4	22	30	59	1050	1569	
%	8.5	3.1	1.8	1.8	2.0	2.0	0.1	0.2	3.6	1.4	1.3	0.3	1.4	1.9	3.8	66.9	100	
%	36.7	13.3	7.7	8.0	8.8	8.8	0.3	0.8	15.5	14.0	12.7	2.5	14.0	19.1	37.6			

SUMMARY ANALYSIS

	NO	%
FUNCTIONAL	1050	66.9
RELATED FAILURE	362	23.1
UNRELATED FAILURE	157	10.0
TOTAL	1569	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

ALL COMPOSITE RESINS

75% Survival = 5.09 YEARS
50% Survival = 10.19 YEARS

YEARLY INTERVAL	*NO. ENTERED*	*NO. LOST*	*NO. FAILED*	*NO. EXPOSED*	*PROPORTION FAILED*	*PROPORTION SURVIVING*	*CUMULATIVE SURVIVAL FUNCTION*	*HAZARD FUNCTION*	*FAILURE DENSITY FUNCTION*
0-1	1,569	172	43	1,483.0	0.0290	0.9710	1.0000	0.0294	0.0290
1-2	1,354	88	86	1,310.0	0.0656	0.9344	0.9710	0.0679	0.0637
2-3	1,180	95	79	1,132.5	0.0698	0.9302	0.9073	0.0723	0.0633
3-4	1,006	179	92	916.5	0.1004	0.8996	0.8440	0.1057	0.0847
4-5	735	131	86	669.5	0.1285	0.8715	0.7593	0.1373	0.0975
5-6	518	48	12	494.0	0.0243	0.9757	0.6617	0.0246	0.0161
6-7	458	45	30	435.5	0.0689	0.9311	0.6456	0.0713	0.0445
7-8	383	59	32	353.5	0.0905	0.9095	0.6012	0.0948	0.0544
8-9	292	71	19	256.5	0.0741	0.9259	0.5468	0.0769	0.0405
10-11	202	61	11	171.5	0.0641	0.9359	0.5063	0.0663	0.0325
11-12	130	11	5	124.5	0.0402	0.9598	0.4738	0.0410	0.0190
12-13	114	29	4	99.5	0.0402	0.9598	0.4548	0.0410	0.0183
13-14	81	6	8	78.0	0.1026	0.8974	0.4365	0.1081	0.0448
14-15	67	17	4	58.5	0.0684	0.9316	0.3917	0.0708	0.0268
15-16	46	37	2	27.5	0.0727	0.9273	0.3649	0.0755	0.0265
16-17	7	0	0	7.0	0.0000	1.0000	0.3384	0.0000	0.0000
17-18	7	0	0	7.0	0.0000	1.0000	0.3384	0.0000	0.0000
18-19	7	1	6	6.5	0.9231	0.0769	0.3384	1.7143	0.3124
19-20	0	0	0	0.0	ERR	ERR	0.0260	ERR	ERR

MATERIALS = ANTERIOR COMPOSITES

CODES = 10103 10104 10801 10802 10901 11001 11402 10502 12201 12202

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	=====	=====
1	-	-	-	-	-	-	-	-	9	-	1	-	1	-	6	72	89	10.5
2	5	1	2	4	-	-	-	-	15	-	1	1	3	7	-	47	86	10.1
3	5	5	1	3	-	-	-	-	11	4	2	-	4	3	-	57	95	11.2
4	18	6	1	4	-	8	-	-	2	1	3	-	1	-	3	133	180	21.2
5	18	5	3	1	-	3	-	1	-	1	1	-	3	2	4	81	123	14.5
6	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	20	22	2.6
7	4	1	-	-	-	2	-	-	-	1	-	-	-	-	4	28	40	4.7
8	2	1	-	-	-	10	-	-	-	-	2	-	1	-	-	36	52	6.1
9	-	1	-	-	-	4	-	-	-	-	-	-	-	-	-	36	41	4.8
10	2	-	-	-	2	1	-	1	-	-	-	-	1	-	1	41	49	5.8
11	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	6	7	0.8
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	19	2.2
13	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-	3	9	1.1
14	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	7	10	1.2
15	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	28	29	3.4
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	58	23	8	12	2	32	-	2	37	7	10	1	15	12	18	614	851	
%	6.8	2.7	0.9	1.4	0.2	3.8	-	0.2	4.3	0.8	1.2	0.1	1.8	1.4	2.1	72.2	100	
%	33.3	13.2	4.6	6.9	1.1	18.4	-	1.1	21.3	11.1	15.9	1.6	23.8	19.0	28.6			

SUMMARY ANALYSIS

	NO	%
	==	====
FUNCTIONAL	614	72.2
RELATED FAILURE	174	20.4
UNRELATED FAILURE	63	7.4
TOTAL	851	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

ANTERIOR COMPOSITES

75% Survival = 5.47 YEARS
50% Survival = 13.49 YEARS

YEARLY INTERVAL	NO. ENTERED	NO. LOST	NO. FAILED	NO. EXPOSED	PROPORTION FAILED	PROPORTION SURVIVING	CUMULATIVE SURVIVAL FUNCTION	HAZARD FUNCTION	FAILURE DENSITY FUNCTION
0-1	851	72	17	815.0	0.0209	0.9791	1.0000	0.0211	0.0209
1-2	762	47	39	738.5	0.0528	0.9472	0.9791	0.0542	0.0517
2-3	676	57	38	647.5	0.0587	0.9413	0.9274	0.0605	0.0544
3-4	581	133	47	514.5	0.0914	0.9086	0.8730	0.0957	0.0797
4-5	401	81	42	360.5	0.1165	0.8835	0.7933	0.1237	0.0924
5-6	278	20	2	268.0	0.0075	0.9925	0.7008	0.0075	0.0052
6-7	256	28	12	242.0	0.0496	0.9504	0.6956	0.0508	0.0345
7-8	216	36	16	198.0	0.0808	0.9192	0.6611	0.0842	0.0534
8-9	164	36	5	146.0	0.0342	0.9658	0.6077	0.0348	0.0208
10-11	123	41	8	102.5	0.0780	0.9220	0.5869	0.0812	0.0458
11-12	74	6	1	71.0	0.0141	0.9859	0.5411	0.0142	0.0076
12-13	67	19	0	57.5	0.0000	1.0000	0.5335	0.0000	0.0000
13-14	48	3	6	46.5	0.1290	0.8710	0.5335	0.1379	0.0688
14-15	39	7	3	35.5	0.0845	0.9155	0.4646	0.0882	0.0393
15-16	29	28	1	15.0	0.0667	0.9333	0.4254	0.0690	0.0284
16-17	0	0	0	0.0	ERR	ERR	0.3970	ERR	ERR
17-18	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
18-19	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
19-20	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR

MATERIALS = POSTERIOR COMPOSITES

CODES = 10102 10601 10803 10804 10805 10806 11401 11403 11404 12302 12303 12501 12502

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
1	1	3	1	-	1	-	-	1	6	1	2	2	2	5	1	100	126	17.5
2	9	6	8	8	5	-	1	-	3	1	2	-	-	-	4	41	88	12.3
3	12	2	7	2	-	-	-	-	2	8	-	-	2	6	-	38	79	11.0
4	20	6	4	4	4	-	-	-	1	1	1	1	-	-	3	46	91	12.7
5	8	4	-	2	5	-	-	-	6	-	3	-	1	-	15	50	94	13.1
6	5	2	-	-	-	-	-	-	-	1	-	-	-	-	2	28	38	5.3
7	7	1	-	-	2	-	-	-	1	-	1	-	1	3	2	17	35	4.9
8	6	-	-	-	4	-	-	-	-	2	-	-	-	1	3	23	39	5.4
9	2	1	-	-	5	-	-	-	-	1	1	-	-	2	2	35	49	6.8
10	1	-	-	1	-	-	-	-	-	-	-	-	1	-	-	20	23	3.2
11	2	-	-	-	1	-	-	-	-	-	-	-	-	-	1	5	9	1.3
12	1	-	-	-	-	-	-	-	-	-	-	-	-	1	2	10	14	1.9
13	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	3	5	0.7
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	10	11	1.5
15	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	9	10	1.4
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	1	-	-	-	-	-	-	-	-	-	5	1	7	1.0
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	75	25	20	17	30	-	1	1	19	15	10	3	7	18	41	436	718	
%	10.4	3.5	2.8	2.4	4.2	-	0.1	0.1	2.6	2.1	1.4	0.4	1.0	2.5	5.7	60.7	100	
%	39.9	13.3	10.6	9.0	16.0	-	0.5	0.5	10.1	16.0	10.6	3.2	7.4	19.1	43.6			

SUMMARY ANALYSIS

	NO	%
FUNCTIONAL	436	60.7
RELATED FAILURE	188	26.2
UNRELATED FAILURE	94	13.1
TOTAL	718	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

POSTERIOR COMPOSITES

75% Survival = 4.64 YEARS
50% Survival = 8.60 YEARS

YEARLY INTERVAL	*NO. ENTERED*	*NO. LOST*	*NO. FAILED*	*NO. EXPOSED*	*PROPORTION FAILED*	*PROPORTION SURVIVING*	*CUMULATIVE SURVIVAL FUNCTION*	*HAZARD FUNCTION*	*FAILURE DENSITY FUNCTION*
0-1	718	100	26	668.0	0.0389	0.9611	1.0000	0.0397	0.0389
1-2	592	41	47	571.5	0.0822	0.9178	0.9611	0.0858	0.0790
2-3	504	38	41	485.0	0.0845	0.9155	0.8820	0.0883	0.0746
3-4	425	46	45	402.0	0.1119	0.8881	0.8075	0.1186	0.0904
4-5	334	50	44	309.0	0.1424	0.8576	0.7171	0.1533	0.1021
5-6	240	28	10	226.0	0.0442	0.9558	0.6150	0.0452	0.0272
6-7	202	17	18	193.5	0.0930	0.9070	0.5878	0.0976	0.0547
7-8	167	23	16	155.5	0.1029	0.8971	0.5331	0.1085	0.0549
8-9	128	35	14	110.5	0.1267	0.8733	0.4782	0.1353	0.0606
10-11	79	20	3	69.0	0.0435	0.9565	0.4176	0.0444	0.0182
11-12	56	5	4	53.5	0.0748	0.9252	0.3995	0.0777	0.0299
12-13	47	10	4	42.0	0.0952	0.9048	0.3696	0.1000	0.0352
13-14	33	3	2	31.5	0.0635	0.9365	0.3344	0.0656	0.0212
14-15	28	10	1	23.0	0.0435	0.9565	0.3132	0.0444	0.0136
15-16	17	9	1	12.5	0.0800	0.9200	0.2996	0.0833	0.0240
16-17	7	0	0	7.0	0.0000	1.0000	0.2756	0.0000	0.0000
17-18	7	0	0	7.0	0.0000	1.0000	0.2756	0.0000	0.0000
18-19	7	1	6	6.5	0.9231	0.0769	0.2756	1.7143	0.2544
19-20	0	0	0	0.0	ERR	ERR	0.0212	ERR	ERR

MATERIALS = CLASS I COMPOSITES

CODES = 10102 10601 10803 10804 10805 10806 11401 11403 11404 12302 12501 12502 12303

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
1	-	-	-	-	-	-	-	-	2	-	-	-	2	4	-	56	64	19.3
2	5	1	5	8	1	-	-	-	-	-	1	-	-	-	-	21	42	12.7
3	2	-	2	1	-	-	-	-	-	3	-	-	-	3	-	21	32	9.6
4	7	1	2	1	2	-	-	-	1	-	-	-	-	-	1	17	32	9.6
5	2	-	-	-	1	-	-	-	2	-	-	-	-	-	11	27	43	13.0
6	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	15	4.5
7	4	-	-	-	1	-	-	-	1	-	-	-	-	1	1	10	18	5.4
8	1	-	-	-	-	-	-	-	-	2	-	-	-	-	2	10	15	4.5
9	-	-	-	-	1	-	-	-	-	1	-	-	-	2	1	26	31	9.3
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	7	2.1
11	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	5	7	2.1
12	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	6	9	2.7
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	0.6
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	7	8	2.4
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	5	1.5
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	0.6
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	22	2	9	10	7	-	-	-	6	6	1	-	2	11	22	234	332	
%	6.6	0.6	2.7	3.0	2.1	-	-	-	1.8	1.8	0.3	-	0.6	3.3	6.6	70.5	100	
%	39.3	3.6	16.1	17.9	12.5	-	-	-	10.7	14.3	2.4	-	4.8	26.2	52.4			

SUMMARY ANALYSIS

	NO	%
FUNCTIONAL	234	70.5
RELATED FAILURE	56	16.9
UNRELATED FAILURE	42	12.7
TOTAL	332	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

CLASS I COMPOSITES

75% Survival = 5.36 YEARS
50% Survival = 12.12 YEARS

YEARLY INTERVAL	NO. ENTERED	NO. LOST	NO. FAILED	NO. EXPOSED	PROPORTION FAILED	PROPORTION SURVIVING	CUMULATIVE SURVIVAL FUNCTION	HAZARD FUNCTION	FAILURE DENSITY FUNCTION
0-1	332	56	8	304.0	0.0263	0.9737	1.0000	0.0267	0.0263
1-2	268	21	21	257.5	0.0816	0.9184	0.9737	0.0850	0.0794
2-3	226	21	11	215.5	0.0510	0.9490	0.8943	0.0524	0.0456
3-4	194	17	15	185.5	0.0809	0.9191	0.8486	0.0843	0.0686
4-5	162	27	16	148.5	0.1077	0.8923	0.7800	0.1139	0.0840
5-6	119	14	1	112.0	0.0089	0.9911	0.6960	0.0090	0.0062
6-7	104	10	8	99.0	0.0808	0.9192	0.6898	0.0842	0.0557
7-8	86	10	5	81.0	0.0617	0.9383	0.6340	0.0637	0.0391
8-9	71	26	5	58.0	0.0862	0.9138	0.5949	0.0901	0.0513
10-11	40	7	0	36.5	0.0000	1.0000	0.5436	0.0000	0.0000
11-12	33	5	2	30.5	0.0656	0.9344	0.5436	0.0678	0.0356
12-13	26	6	3	23.0	0.1304	0.8696	0.5079	0.1395	0.0663
13-14	17	2	0	16.0	0.0000	1.0000	0.4417	0.0000	0.0000
14-15	15	7	1	11.5	0.0870	0.9130	0.4417	0.0909	0.0384
15-16	7	5	0	4.5	0.0000	1.0000	0.4033	0.0000	0.0000
16-17	2	0	0	2.0	0.0000	1.0000	0.4033	0.0000	0.0000
17-18	2	0	0	2.0	0.0000	1.0000	0.4033	0.0000	0.0000
18-19	2	0	2	2.0	1.0000	0.0000	0.4033	2.0000	0.4033
19-20	0	0	0	0.0	ERR	ERR	0.0000	ERR	ERR

MATERIALS = CLASS II COMPOSITES

CODES = 10102 10601 10803 10804 10805 10806 11401 11403 11404 12302 12501 12502 12303

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	=====	=====
1	1	3	1	-	1	-	-	1	4	1	2	2	-	1	1	44	62	16.1
2	4	5	3	-	4	-	1	-	3	1	1	-	-	-	4	20	46	11.9
3	10	2	5	1	-	-	-	-	2	5	-	-	2	3	-	17	47	12.2
4	13	5	2	3	2	-	-	-	-	1	1	1	-	-	2	29	59	15.3
5	6	4	-	2	4	-	-	-	4	-	3	-	1	-	4	23	51	13.2
6	4	2	-	-	-	-	-	-	-	1	-	-	-	-	2	14	23	6.0
7	3	1	-	-	1	-	-	-	-	-	1	-	1	2	1	7	17	4.4
8	5	-	-	-	4	-	-	-	-	-	-	-	-	1	1	13	24	6.2
9	2	1	-	-	4	-	-	-	-	-	1	-	-	-	1	9	18	4.7
10	1	-	-	1	-	-	-	-	-	-	-	-	1	-	-	13	16	4.1
11	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.5
12	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5	1.3
13	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	3	0.8
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	0.8
15	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	4	5	1.3
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	1	-	-	-	-	-	-	-	-	-	3	1	5	1.3
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	53	23	11	7	23	-	1	1	13	9	9	3	5	7	19	202	386	
%	13.7	6.0	2.8	1.8	6.0	-	0.3	0.3	3.4	2.3	2.3	0.8	1.3	1.8	4.9	52.3	100	
%	40.2	17.4	8.3	5.3	17.4	-	0.8	0.8	9.8	17.3	17.3	5.8	9.6	13.5	36.5			

SUMMARY ANALYSIS

	NO	%
	==	====
FUNCTIONAL	202	52.3
RELATED FAILURE	132	34.2
UNRELATED FAILURE	52	13.5
TOTAL	386	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

CLASS II COMPOSITES

75% Survival = 4.23 YEARS
50% Survival = 7.14 YEARS

YEARLY INTERVAL	*NO. ENTERED*	*NO. LOST*	*NO. FAILED*	*NO. EXPOSED*	*PROPORTION FAILED*	*PROPORTION SURVIVING*	*CUMULATIVE SURVIVAL FUNCTION*	*HAZARD FUNCTION*	*FAILURE DENSITY FUNCTION*
0-1	386	44	18	364.0	0.0495	0.9505	1.0000	0.0507	0.0495
1-2	324	20	26	314.0	0.0828	0.9172	0.9505	0.0864	0.0787
2-3	278	17	30	269.5	0.1113	0.8887	0.8718	0.1179	0.0971
3-4	231	29	30	216.5	0.1386	0.8614	0.7748	0.1489	0.1074
4-5	172	23	28	160.5	0.1745	0.8255	0.6674	0.1911	0.1164
5-6	121	14	9	114.0	0.0789	0.9211	0.5510	0.0822	0.0435
6-7	98	7	10	94.5	0.1058	0.8942	0.5075	0.1117	0.0537
7-8	81	13	11	74.5	0.1477	0.8523	0.4538	0.1594	0.0670
8-9	57	9	9	52.5	0.1714	0.8286	0.3868	0.1875	0.0663
10-11	39	13	3	32.5	0.0923	0.9077	0.3205	0.0968	0.0296
11-12	23	0	2	23.0	0.0870	0.9130	0.2909	0.0909	0.0253
12-13	21	4	1	19.0	0.0526	0.9474	0.2656	0.0541	0.0140
13-14	16	1	2	15.5	0.1290	0.8710	0.2516	0.1379	0.0325
14-15	13	3	0	11.5	0.0000	1.0000	0.2192	0.0000	0.0000
15-16	10	4	1	8.0	0.1250	0.8750	0.2192	0.1333	0.0274
16-17	5	0	0	5.0	0.0000	1.0000	0.1918	0.0000	0.0000
17-18	5	0	0	5.0	0.0000	1.0000	0.1918	0.0000	0.0000
18-19	5	1	4	4.5	0.8889	0.1111	0.1918	1.6000	0.1705
19-20	0	0	0	0.0	ERR	ERR	0.0213	ERR	ERR

MATERIALS = ALL AMALGAM ALLOYS

CODES = 10301 10302 10303 10306 10311 10401 10402 10701 11101 11201 11301 11309 12102 12104 10501 12402 10304 11302 10305 10309 10310 11102 11103 11202 11303 11306 11307 11308 12101 12103 12401

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	=====	=====
1	-	2	2	-	-	-	-	1	3	2	5	3	6	6	1	240	271	15.7
2	6	15	4	-	-	-	-	-	2	2	5	2	8	3	4	103	154	8.9
3	12	13	17	-	-	-	1	-	2	4	7	-	1	2	7	87	153	8.9
4	6	5	8	1	-	-	-	-	2	2	5	-	1	1	10	136	177	10.2
5	10	6	4	-	-	-	-	-	3	7	8	-	3	6	5	232	284	16.4
6	3	3	-	-	-	-	-	-	-	2	2	3	2	-	2	110	127	7.4
7	3	4	-	1	-	-	-	-	-	-	2	-	2	-	5	73	90	5.2
8	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	73	77	4.5
9	2	1	-	-	-	-	-	-	-	2	5	-	1	2	1	91	105	6.1
10	1	1	1	-	-	-	-	1	-	3	2	-	1	-	1	38	49	2.8
11	1	2	-	-	-	-	-	-	-	2	1	-	2	-	3	73	84	4.9
12	-	2	-	-	-	-	-	-	-	4	-	-	4	1	3	55	69	4.0
13	-	-	-	-	-	-	-	-	-	-	-	-	2	4	1	24	31	1.8
14	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	11	12	0.7
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	5	0.3
16	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	0.1
17	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	2	4	0.2
18	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	16	17	1.0
19	-	-	-	-	1	-	-	-	-	-	-	-	2	-	-	13	16	0.9
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	49	55	36	2	1	-	1	2	12	32	44	8	35	25	43	1382	1727	
%	2.8	3.2	2.1	0.1	0.1	-	0.1	0.1	0.7	1.9	2.5	0.5	2.0	1.4	2.5	80.0	100	
%	31.0	34.8	22.8	1.3	0.6	-	0.6	1.3	7.6	17.1	23.5	4.3	18.7	13.4	23.0			

SUMMARY ANALYSIS

	NO	%
	==	====
FUNCTIONAL	1382	80.0
RELATED FAILURE	158	9.1
UNRELATED FAILURE	187	10.8
TOTAL	1727	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

ALL AMALGAM ALLOYS

75% Survival = 9.16 YEARS
50% Survival = 16.77 YEARS

YEARLY INTERVAL	*NO. ENTERED*	*NO. LOST*	*NO. FAILED*	*NO. EXPOSED*	*PROPORTION FAILED*	*PROPORTION SURVIVING*	*CUMULATIVE SURVIVAL FUNCTION*	*HAZARD FUNCTION*	*FAILURE DENSITY FUNCTION*
0-1	1,727	240	31	1,607.0	0.0193	0.9807	1.0000	0.0195	0.0193
1-2	1,456	103	51	1,404.5	0.0363	0.9637	0.9807	0.0370	0.0356
2-3	1,302	87	66	1,258.5	0.0524	0.9476	0.9451	0.0539	0.0496
3-4	1,149	136	41	1,081.0	0.0379	0.9621	0.8955	0.0387	0.0340
4-5	972	232	52	856.0	0.0607	0.9393	0.8616	0.0627	0.0523
5-6	688	110	17	633.0	0.0269	0.9731	0.8092	0.0272	0.0217
6-7	561	73	17	524.5	0.0324	0.9676	0.7875	0.0329	0.0255
7-8	471	73	4	434.5	0.0092	0.9908	0.7620	0.0092	0.0070
8-9	394	91	14	348.5	0.0402	0.9598	0.7550	0.0410	0.0303
10-11	289	38	11	270.0	0.0407	0.9593	0.7246	0.0416	0.0295
11-12	240	73	11	203.5	0.0541	0.9459	0.6951	0.0556	0.0376
12-13	156	55	14	128.5	0.1089	0.8911	0.6575	0.1152	0.0716
13-14	87	24	7	75.0	0.0933	0.9067	0.5859	0.0979	0.0547
14-15	56	11	1	50.5	0.0198	0.9802	0.5312	0.0200	0.0105
15-16	44	5	0	41.5	0.0000	1.0000	0.5207	0.0000	0.0000
16-17	39	0	2	39.0	0.0513	0.9487	0.5207	0.0526	0.0267
17-18	37	2	2	36.0	0.0556	0.9444	0.4940	0.0571	0.0274
18-19	33	16	1	25.0	0.0400	0.9600	0.4665	0.0408	0.0187
19-20	16	13	3	9.5	0.3158	0.6842	0.4479	0.3750	0.1414

MATERIALS = CLASS I AMALGAM ALLOYS

CODES = 10301 10302 10303 10306 10311 10401 10402 10701 11101 11201 11301 11309 12102 12104 10501 12402 10304 11302 10305 10309 10310 11102 11103 11202 11303 11306 11307 11308 12101 12103 12401

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	=====	=====
1	-	-	-	-	-	-	-	-	-	1	-	-	-	2	-	98	101	13.9
2	4	1	-	-	-	-	-	-	1	-	1	-	1	2	2	39	51	7.0
3	4	-	4	-	-	-	-	-	1	3	2	-	-	-	1	48	63	8.6
4	2	1	4	1	-	-	-	-	-	-	1	-	-	1	5	53	68	9.3
5	4	3	1	-	-	-	-	-	1	4	1	-	-	2	2	123	141	19.3
6	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	67	70	9.6
7	1	1	-	-	-	-	-	-	-	-	1	-	-	-	2	30	35	4.8
8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32	33	4.5
9	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	38	40	5.5
10	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	25	27	3.7
11		-	-	-	-	-	-	-	-	-	-	-	-	-	2	35	37	5.1
12		1	-	-	-	-	-	-	-	4	-	-	-	-	-	19	24	3.3
13	-	-	-	-	-	-	-	-	-	-	-	-	1	2	1	10	14	1.9
14	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	8	9	1.2
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	0.3
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.1
18	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	6	7	1.0
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	6	0.8
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	16	7	9	1	-	-	-	1	3	16	7	-	2	10	17	640	729	
%	2.2	1.0	1.2	0.1	-	-	-	0.1	0.4	2.2	1.0	-	0.3	1.4	2.3	87.8	100	
%	43.2	18.9	24.3	2.7	-	-	-	2.7	8.1	30.8	13.5	-	3.8	19.2	32.7			

SUMMARY ANALYSIS

	NO	%
	==	====
FUNCTIONAL	640	87.8
RELATED FAILURE	37	5.1
UNRELATED FAILURE	52	7.1
TOTAL	729	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

CLASS I AMALGAM ALLOYS

75% Survival = 12.64 YEARS
50% Survival = >19.0 YEARS

YEARLY INTERVAL	*NO. ENTERED*	*NO. LOST*	*NO. FAILED*	*NO. EXPOSED*	*PROPORTION FAILED*	*PROPORTION SURVIVING*	*CUMULATIVE SURVIVAL FUNCTION*	*HAZARD FUNCTION*	*FAILURE DENSITY FUNCTION*
0-1	729	98	3	680.0	0.0044	0.9956	1.0000	0.0044	0.0044
1-2	628	39	12	608.5	0.0197	0.9803	0.9956	0.0199	0.0196
2-3	577	48	15	553.0	0.0271	0.9729	0.9760	0.0275	0.0265
3-4	514	53	15	487.5	0.0308	0.9692	0.9495	0.0313	0.0292
4-5	446	123	18	384.5	0.0468	0.9532	0.9203	0.0479	0.0431
5-6	305	67	3	271.5	0.0110	0.9890	0.8772	0.0111	0.0097
6-7	235	30	5	220.0	0.0227	0.9773	0.8675	0.0230	0.0197
7-8	200	32	1	184.0	0.0054	0.9946	0.8478	0.0054	0.0046
8-9	167	38	2	148.0	0.0135	0.9865	0.8432	0.0136	0.0114
10-11	127	25	2	114.5	0.0175	0.9825	0.8318	0.0176	0.0145
11-12	100	35	2	82.5	0.0242	0.9758	0.8172	0.0245	0.0198
12-13	63	19	5	53.5	0.0935	0.9065	0.7974	0.0980	0.0745
13-14	39	10	4	34.0	0.1176	0.8824	0.7229	0.1250	0.0850
14-15	25	8	1	21.0	0.0476	0.9524	0.6379	0.0488	0.0304
15-16	16	2	0	15.0	0.0000	1.0000	0.6075	0.0000	0.0000
16-17	14	0	0	14.0	0.0000	1.0000	0.6075	0.0000	0.0000
17-18	14	1	0	13.5	0.0000	1.0000	0.6075	0.0000	0.0000
18-19	13	6	1	10.0	0.1000	0.9000	0.6075	0.1053	0.0607
19-20	6	6	0	3.0	0.0000	1.0000	0.5467	0.0000	0.0000

MATERIALS = CLASS II AMALGAM ALLOYS

CODES = 10301 10302 10303 10306 10311 10401 10402 10701 11101 11201 11301 11309 12102 12104 10501 12402 10304 11302 10305 10309 10310 11102 11103 11202 11303 11306 11307 11308 12101 12103 12401

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	=====	=====
1	-	2	2	-	-	-	-	1	3	1	5	3	6	4	1	142	170	17.0
2	2	14	4	-	-	-	-	-	1	2	4	2	7	1	2	64	103	10.3
3	8	13	13	-	-	-	1	-	1	1	5	-	1	2	6	39	90	9.0
4	4	4	4	-	-	-	-	-	2	2	4	-	1	-	5	83	109	10.9
5	6	3	3	-	-	-	-	-	2	3	7	-	3	4	3	109	143	3
6	3	3	-	-	-	-	-	-	-	1	2	3	2	-	-	43	57	7
7	2	3	-	1	-	-	-	-	-	-	1	-	2	-	3	43	55	..5
8	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	41	44	4.4
9	2	1	-	-	-	-	-	-	-	2	4	-	1	1	1	53	65	6.5
10	1	1	1	-	-	-	-	-	-	2	2	-	1	-	1	13	22	2.2
11	1	2	-	-	-	-	-	-	-	2	1	-	2	-	1	38	47	4.7
12	-	1	-	-	-	-	-	-	-	-	-	-	4	1	3	36	45	4.5
13	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	14	17	1.7
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	0.3
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	0.3
16	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	0.2
17	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	1	3	0.3
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	10	1.0
19	-	-	-	-	1	-	-	-	-	-	-	-	2	-	-	7	10	1.0
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	33	48	27	1	1	-	1	1	9	16	37	8	33	15	26	742	998	
%	3.3	4.8	2.7	0.1	0.1	-	0.1	0.1	0.9	1.6	3.7	0.8	3.3	1.5	2.6	74.3	100	
%	27.3	39.7	22.3	0.8	0.8	-	0.8	0.8	7.4	11.9	27.4	5.9	24.4	11.1	19.3			

SUMMARY ANALYSIS

	NO	%
	==	====
FUNCTIONAL	742	74.3
RELATED FAILURE	121	12.1
UNRELATED FAILURE	135	13.5
TOTAL	998	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

CLASS II AMALGAM ALLOYS

75% Survival = 6.31 YEARS
50% Survival = 13.00 YEARS

YEARLY INTERVAL	NO. ENTERED	NO. LOST	NO. FAILED	NO. EXPOSED	PROPORTION FAILED	PROPORTION SURVIVING	CUMULATIVE SURVIVAL FUNCTION	HAZARD FUNCTION	FAILURE DENSITY FUNCTION
0-1	998	142	28	927.0	0.0302	0.9698	1.0000	0.0307	0.0302
1-2	828	64	39	796.0	0.0490	0.9510	0.9698	0.0502	0.0475
2-3	725	39	51	705.5	0.0723	0.9277	0.9223	0.0750	0.0667
3-4	635	83	26	593.5	0.0438	0.9562	0.8556	0.0448	0.0375
4-5	526	109	34	471.5	0.0721	0.9279	0.8181	0.0748	0.0590
5-6	383	43	14	361.5	0.0387	0.9613	0.7591	0.0395	0.0294
6-7	326	43	12	304.5	0.0394	0.9606	0.7297	0.0402	0.0288
7-8	271	41	3	250.5	0.0120	0.9880	0.7010	0.0120	0.0084
8-9	227	53	12	200.5	0.0599	0.9401	0.6926	0.0617	0.0415
10-11	162	13	9	155.5	0.0579	0.9421	0.6511	0.0596	0.0377
11-12	140	38	9	121.0	0.0744	0.9256	0.6134	0.0773	0.0456
12-13	93	36	9	75.0	0.1200	0.8800	0.5678	0.1277	0.0681
13-14	48	14	3	41.0	0.0732	0.9268	0.4997	0.0759	0.0366
14-15	31	3	0	29.5	0.0000	1.0000	0.4631	0.0000	0.0000
15-16	28	3	0	26.5	0.0000	1.0000	0.4631	0.0000	0.0000
16-17	25	0	2	25.0	0.0800	0.9200	0.4631	0.0833	0.0370
17-18	23	1	2	22.5	0.0889	0.9111	0.4261	0.0930	0.0379
18-19	20	10	0	15.0	0.0000	1.0000	0.3882	0.0000	0.0000
19-20	10	7	3	6.5	0.4615	0.5385	0.3882	0.6000	0.1792

MATERIALS = ALL POLISHED AMALGAMS

CODES = 10301 10302 10303 10306 10311 10401 10402 10701 11101 11201 11301 11309 12102 12104 10501 12402

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
1	-	1	2	-	-	-	-	-	2	1	3	3	4	6	1	131	154	15.8
2	5	11	3	-	-	-	-	-	1	2	4	1	8	2	1	58	96	9.8
3	9	5	15	-	-	-	1	-	1	2	2	-	1	1	5	26	68	7.0
4	3	3	8	1	-	-	-	-	1	1	1	-	-	1	4	84	107	11.0
5	6	4	4	-	-	-	-	-	3	5	6	-	2	4	4	167	205	21.0
6	1	3	-	-	-	-	-	-	-	1	1	2	2	-	2	58	70	7.2
7	1	-	-	-	-	-	-	-	-	-	-	-	1	-	3	18	23	2.4
8	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31	33	3.4
9	-	-	-	-	-	-	-	-	-	-	2	-	-	1	1	39	43	4.4
10	-	1	-	-	-	-	-	1	-	2	1	-	-	-	1	16	22	2.3
11	1	1	-	-	-	-	-	-	-	1	1	-	2	-	3	14	23	2.4
12	-	2	-	-	-	-	-	-	-	3	-	-	3	1	3	32	44	4.5
13	-	-	-	-	-	-	-	-	-	-	-	-	2	4	1	24	31	3.2
14	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	11	12	1.2
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	5	0.5
16	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	0.2
17	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	2	4	0.4
18	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	16	17	1.7
19	-	-	-	-	1	-	-	-	-	-	-	-	2	-	-	13	16	1.6
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	29	32	32	1	1	-	1	1	8	20	23	6	27	20	29	745	975	
%	3.0	3.3	3.3	0.1	0.1	-	0.1	0.1	0.8	2.1	2.4	0.6	2.8	2.1	3.0	76.4	100	
%	27.6	30.5	30.5	1.0	1.0	-	1.0	1.0	7.6	16.0	18.4	4.8	21.6	16.0	23.2			

SUMMARY ANALYSIS

	NO	%
FUNCTIONAL	745	76.4
RELATED FAILURE	105	10.8
UNRELATED FAILURE	125	12.8
TOTAL	975	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

ALL POLISHED AMALGAMS

75% Survival = 6.75 YEARS
50% Survival = 16.39 YEARS

YEARLY INTERVAL	NO. ENTERED	NO. LOST	NO. FAILED	NO. EXPOSED	PROPORTION FAILED	PROPORTION SURVIVING	CUMULATIVE SURVIVAL FUNCTION	HAZARD FUNCTION	FAILURE DENSITY FUNCTION
0-1	975	131	23	909.5	0.0253	0.9747	1.0000	0.0256	0.0253
1-2	821	58	38	792.0	0.0480	0.9520	0.9747	0.0492	0.0468
2-3	725	26	42	712.0	0.0590	0.9410	0.9279	0.0608	0.0547
3-4	657	84	23	615.0	0.0374	0.9626	0.8732	0.0381	0.0327
4-5	550	167	38	466.5	0.0815	0.9185	0.8406	0.0849	0.0685
5-6	345	58	12	316.0	0.0380	0.9620	0.7721	0.0387	0.0293
6-7	275	18	5	266.0	0.0188	0.9812	0.7428	0.0190	0.0140
7-8	252	31	2	236.5	0.0085	0.9915	0.7288	0.0085	0.0062
8-9	219	39	4	199.5	0.0201	0.9799	0.7226	0.0203	0.0145
10-11	176	16	6	168.0	0.0357	0.9643	0.7081	0.0364	0.0253
11-12	154	14	9	147.0	0.0612	0.9388	0.6829	0.0632	0.0418
12-13	131	32	12	115.0	0.1043	0.8957	0.6410	0.1101	0.0669
13-14	87	24	7	75.0	0.0933	0.9067	0.5742	0.0979	0.0536
14-15	56	11	1	50.5	0.0198	0.9802	0.5206	0.0200	0.0103
15-16	44	5	0	41.5	0.0000	1.0000	0.5103	0.0000	0.0000
16-17	39	0	2	39.0	0.0513	0.9487	0.5103	0.0526	0.0262
17-18	37	2	2	36.0	0.0556	0.9444	0.4841	0.0571	0.0269
18-19	33	16	1	25.0	0.0400	0.9600	0.4572	0.0408	0.0183
19-20	16	13	3	9.5	0.3158	0.6842	0.4389	0.3750	0.1386

MATERIALS = ALL UNPOLISHED AMALGAMS

CODES = 10305 10309 10310 11102 11103 11202 11303 11306 11307 11308 12101 12103 12401

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	====	=====	=====
1	-	1	-	-	-	-	-	-	1	1	2	-	2	-	-	94	101	15.6
2	1	3	1	-	-	-	-	-	1	-	1	1	-	-	3	37	48	7.4
3	3	6	2	-	-	-	-	-	-	2	5	-	-	-	1	54	73	11.2
4	3	2	-	-	-	-	-	-	1	1	4	-	1	-	5	43	60	9.2
5	3	2	-	-	-	-	-	-	-	1	2	-	1	1	1	62	73	11.2
6	2	-	-	-	-	-	-	-	-	1	1	1	-	-	-	50	55	8.5
7	1	2	-	1	-	-	-	-	-	-	2	-	1	-	1	40	48	7.4
8	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31	33	5.1
9	2	1	-	-	-	-	-	-	-	2	3	-	1	1	-	51	61	9.4
10	1	-	1	-	-	-	-	-	-	1	1	-	1	-	-	22	27	4.2
11	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	53	55	8.5
12	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	14	15	2.3
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	18	18	4	1	-	-	-	-	3	10	21	2	8	2	11	551	649	
%	2.8	2.8	0.6	0.2	-	-	-	-	0.5	1.5	3.2	0.3	1.2	0.3	1.7	84.9	100	
%	40.9	40.9	9.1	2.3	-	-	-	-	6.8	18.5	38.9	3.7	14.8	3.7	20.4			

SUMMARY ANALYSIS

	NO	%
	==	====
FUNCTIONAL	551	84.9
RELATED FAILURE	44	6.8
UNRELATED FAILURE	54	8.3
TOTAL	649	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

ALL UNPOLISHED AMALGAMS

75% Survival = 9.90 YEARS
50% Survival = >13.0 YEARS

YEARLY INTERVAL	NO. ENTERED	NO. LOST	NO. FAILED	NO. EXPOSED	PROPORTION FAILED	PROPORTION SURVIVING	CUMULATIVE SURVIVAL FUNCTION	HAZARD FUNCTION	FAILURE DENSITY FUNCTION
0-1	649	94	7	602.0	0.0116	0.9884	1.0000	0.0117	0.0116
1-2	548	37	11	529.5	0.0208	0.9792	0.9884	0.0210	0.0205
2-3	500	54	19	473.0	0.0402	0.9598	0.9678	0.0410	0.0389
3-4	427	43	17	405.5	0.0419	0.9581	0.9290	0.0428	0.0389
4-5	367	62	11	336.0	0.0327	0.9673	0.8900	0.0333	0.0291
5-6	294	50	5	269.0	0.0186	0.9814	0.8609	0.0188	0.0160
6-7	239	40	8	219.0	0.0365	0.9635	0.8449	0.0372	0.0309
7-8	191	31	2	175.5	0.0114	0.9886	0.8140	0.0115	0.0093
8-9	158	51	10	132.5	0.0755	0.9245	0.8047	0.0784	0.0607
10-11	97	22	5	86.0	0.0581	0.9419	0.7440	0.0599	0.0433
11-12	70	53	2	43.5	0.0460	0.9540	0.7007	0.0471	0.0322
12-13	15	14	1	8.0	0.1250	0.8750	0.6685	0.1333	0.0836
13-14	0	0	0	0.0	ERR	ERR	0.5850	ERR	ERR
14-15	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
15-16	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
16-17	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
17-18	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
18-19	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
19-20	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR

MATERIALS = HIGH COPPER AMALGAM ALLOYS

CODES = 10301 10302 10303 10306 10311 11101 11301 11309 12102 12104 12105 12402 10304 11302 10305 10309 10310 11102 11103 11303 11306 11307 11308 12101 12103 12401

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
1	-	2	1	-	-	-	-	1	2	1	5	2	5	5	1	182	207	15.2
2	2	14	1	-	-	-	-	-	2	-	4	2	8	3	3	89	128	9.4
3	9	11	4	-	-	-	1	-	2	4	7	-	1	2	5	74	120	8.8
4	6	5	3	-	-	-	-	-	2	2	5	-	1	-	9	100	133	9.7
5	9	6	2	-	-	-	-	-	1	6	7	-	3	6	3	180	223	16.3
6	3	3	-	-	-	-	-	-	-	2	1	3	2	-	-	108	122	8.9
7	2	4	-	1	-	-	-	-	-	-	2	-	1	-	2	59	71	5.2
8	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	61	65	4.8
9	2	1	-	-	-	-	-	-	-	2	5	-	1	2	-	89	102	7.5
10	1	1	-	-	-	-	-	-	-	2	1	-	1	-	-	36	42	3.1
11	1	2	-	-	-	-	-	-	-	1	-	-	2	-	1	67	74	5.4
12	-	-	-	-	-	-	-	-	-	2	-	-	2	-	2	35	41	3.0
13	-	-	-	-	-	-	-	-	-	-	-	-	2	2	1	15	20	1.5
14	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	4	5	0.4
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.1
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.1
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	0.2
19	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	6	8	0.6
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	39	50	11	1	1	-	1	1	9	23	37	7	30	20	27	1109	1366	
%	2.9	3.7	0.8	0.1	0.1	-	0.1	0.1	0.7	1.7	2.7	0.5	2.2	1.5	2.0	81.2	100	
%	34.5	44.2	9.7	0.9	0.9	-	0.9	0.9	8.0	16.0	25.7	4.9	20.8	13.9	18.8			

SUMMARY ANALYSIS

	NO	%
FUNCTIONAL	1109	81.2
RELATED FAILURE	113	8.3
UNRELATED FAILURE	144	10.5
TOTAL	1366	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

HIGH COPPER AMALGAM ALLOYS

75% Survival = 9.20 YEARS
50% Survival = 13.93 YEARS

YEARLY INTERVAL	*NO. ENTERED*	*NO. LOST*	*NO. FAILED*	*NO. EXPOSED*	*PROPORTION FAILED*	*PROPORTION SURVIVING*	*CUMULATIVE SURVIVAL FUNCTION*	*HAZARD FUNCTION*	*FAILURE DENSITY FUNCTION*
0-1	1,366	182	25	1,275.0	0.0196	0.9804	1.0000	0.0198	0.0196
1-2	1,159	89	39	1,114.5	0.0350	0.9650	0.9804	0.0356	0.0343
2-3	1,031	74	46	994.0	0.0463	0.9537	0.9461	0.0474	0.0438
3-4	911	100	33	861.0	0.0383	0.9617	0.9023	0.0391	0.0346
4-5	778	180	43	688.0	0.0625	0.9375	0.8677	0.0645	0.0542
5-6	555	108	14	501.0	0.0279	0.9721	0.8135	0.0283	0.0227
6-7	433	59	12	403.5	0.0297	0.9703	0.7908	0.0302	0.0235
7-8	362	61	4	331.5	0.0121	0.9879	0.7672	0.0121	0.0093
8-9	297	89	13	252.5	0.0515	0.9485	0.7580	0.0528	0.0390
10-11	195	36	6	177.0	0.0339	0.9661	0.7190	0.0345	0.0244
11-12	153	67	7	119.5	0.0586	0.9414	0.6946	0.0603	0.0407
12-13	79	35	6	61.5	0.0976	0.9024	0.6539	0.1026	0.0638
13-14	38	15	5	30.5	0.1639	0.8361	0.5901	0.1786	0.0967
14-15	18	4	1	16.0	0.0625	0.9375	0.4934	0.0645	0.0308
15-16	13	1	0	12.5	0.0000	1.0000	0.4625	0.0000	0.0000
16-17	12	0	0	12.0	0.0000	1.0000	0.4625	0.0000	0.0000
17-18	12	0	1	12.0	0.0833	0.9167	0.4625	0.0870	0.0385
18-19	11	3	0	9.5	0.0000	1.0000	0.4240	0.0000	0.0000
19-20	8	6	2	5.0	0.4000	0.6000	0.4240	0.5000	0.1696

MATERIALS = LOW COPPER AMALGAM ALLOYS

CODES = 10401 10402 10701 12101 10501 11201 11202

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
1	-	-	1	-	-	-	-	-	1	1	-	1	1	1	-	66	72	17.9
2	4	1	3	-	-	-	-	-	-	2	1	-	-	-	1	15	27	6.7
3	5	2	13	-	-	-	-	-	-	-	1	-	-	-	3	18	42	10.4
4	1	-	5	1	-	-	-	-	-	-	-	-	-	1	1	40	49	12.2
5	1	-	2	-	-	-	-	-	2	1	1	-	-	1	2	55	65	16.1
6	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2	5	8	2.0
7	1	-	-	-	-	-	-	-	-	-	-	-	1	-	3	15	20	5.0
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	12	3.0
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	4	1.0
10	1	-	1	-	-	-	-	1	-	1	1	-	1	-	1	10	17	4.2
11	-	-	-	-	-	-	-	-	-	1	1	-	-	-	2	6	10	2.5
12	-	2	-	-	-	-	-	-	-	2	-	-	2	1	1	20	28	6.9
13	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	9	11	2.7
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	7	1.7
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	1.0
16	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	0.5
17	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	3	0.7
18	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	13	14	3.5
19	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	7	8	2.0
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	14	5	25	1	-	-	-	1	3	9	8	1	6	6	17	307	403	
%	3.5	1.2	6.2	0.2	-	-	-	0.2	0.7	2.2	2.0	0.2	1.5	1.5	4.2	76.2	100	
%	28.6	10.2	51.0	2.0	-	-	-	2.0	6.1	19.1	17.0	2.1	12.8	12.8	36.2			

SUMMARY ANALYSIS

	NO	%
FUNCTIONAL	307	76.2
RELATED FAILURE	49	12.2
UNRELATED FAILURE	47	11.7
TOTAL	403	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

LOW COPPER AMALGAM ALLOYS

75% Survival = 7.90 YEARS
50% Survival = 17.47 YEARS

YEARLY INTERVAL	*NO. ENTERED*	*NO. LOST*	*NO. FAILED*	*NO. EXPOSED*	*PROPORTION FAILED*	*PROPORTION SURVIVING*	*CUMULATIVE SURVIVAL FUNCTION*	*HAZARD FUNCTION*	*FAILURE DENSITY FUNCTION*
0-1	403	66	6	370.0	0.0162	0.9838	1.0000	0.0163	0.0162
1-2	331	15	12	323.5	0.0371	0.9629	0.9838	0.0378	0.0365
2-3	304	18	24	295.0	0.0814	0.9186	0.9473	0.0848	0.0771
3-4	262	40	9	242.0	0.0372	0.9628	0.8702	0.0379	0.0324
4-5	213	55	10	185.5	0.0539	0.9461	0.8379	0.0554	0.0452
5-6	148	5	3	145.5	0.0206	0.9794	0.7927	0.0208	0.0163
6-7	140	15	5	132.5	0.0377	0.9623	0.7763	0.0385	0.0293
7-8	120	12	0	114.0	0.0000	1.0000	0.7471	0.0000	0.0000
8-9	108	3	1	106.5	0.0094	0.9906	0.7471	0.0094	0.0070
10-11	104	10	7	99.0	0.0707	0.9293	0.7400	0.0733	0.0523
11-12	87	6	4	84.0	0.0476	0.9524	0.6877	0.0488	0.0327
12-13	77	20	8	67.0	0.1194	0.8806	0.6550	0.1270	0.0782
13-14	49	9	2	44.5	0.0449	0.9551	0.5768	0.0460	0.0259
14-15	38	7	0	34.5	0.0000	1.0000	0.5508	0.0000	0.0000
15-16	31	4	0	29.0	0.0000	1.0000	0.5508	0.0000	0.0000
16-17	27	0	2	27.0	0.0741	0.9259	0.5508	0.0769	0.0408
17-18	25	2	1	24.0	0.0417	0.9583	0.5100	0.0426	0.0213
18-19	22	13	1	15.5	0.0645	0.9355	0.4888	0.0667	0.0315
19-20	8	7	1	4.5	0.2222	0.7778	0.4572	0.2500	0.1016

MATERIALS = HIGH COPPER CLASS II AMALGAM ALLOYS

CODES = 10301 10302 10303 10306 13011 11101 11301 11309 12102 12104 12105 12402 10304 11302 10305 10309 10310 11102 11103 11303 11306 11307 11308 12101 12103 12401

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
1	-	2	1	-	-	-	-	1	2	1	4	2	5	3	1	101	123	16.5
2	2	12	1	-	-	-	-	-	1	-	3	2	7	1	2	51	82	11.0
3	6	11	3	-	-	-	1	-	1	1	5	-	1	2	4	31	66	8.9
4	4	4	2	-	-	-	-	-	2	2	4	-	1	-	5	55	79	10.6
5	6	3	2	-	-	-	-	-	1	2	5	-	2	4	3	76	104	14.0
6	3	3	-	-	-	-	-	-	-	1	1	2	2	-	-	37	49	6.6
7	1	3	-	1	-	-	-	-	-	-	1	-	1	-	1	30	38	5.1
8	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35	38	5.1
9	2	1	-	-	-	-	-	-	-	2	3	-	1	1	-	43	53	7.1
10	1	1	-	-	-	-	-	-	-	2	1	-	1	-	-	12	18	2.4
11	1	2	-	-	-	-	-	-	-	1	-	-	2	-	1	34	41	5.5
12	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	24	28	3.8
13	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	11	13	1.7
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	0.3
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.1
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.1
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	0.4
19	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	3	5	0.7
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	29	43	9	1	1	-	1	1	7	12	27	6	27	12	19	549	744	
%	3.9	5.8	1.2	0.1	0.1	-	0.1	0.1	0.9	1.6	3.6	0.8	3.6	1.6	2.6	73.8	100	
%	31.5	46.7	9.8	1.1	1.1	-	1.1	1.1	7.6	11.7	26.2	5.8	26.2	11.7	18.4			

SUMMARY ANALYSIS

	NO	%
FUNCTIONAL	549	73.8
RELATED FAILURE	92	12.4
UNRELATED FAILURE	103	13.8
TOTAL	744	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

HIGH COPPER CLASS II AMALGAM ALLOYS

75% Survival = 5.95 YEARS
50% Survival = 12.77 YEARS

YEARLY INTERVAL	*NO. ENTERED*	*NO. LOST*	*NO. FAILED*	*NO. EXPOSED*	*PROPORTION FAILED*	*PROPORTION SURVIVING*	*CUMULATIVE SURVIVAL FUNCTION*	*HAZARD FUNCTION*	*FAILURE DENSITY FUNCTION*
0-1	744	101	22	693.5	0.0317	0.9683	1.0000	0.0322	0.0317
1-2	621	51	31	595.5	0.0521	0.9479	0.9683	0.0534	0.0504
2-3	539	31	35	523.5	0.0669	0.9331	0.9179	0.0692	0.0614
3-4	473	55	24	445.5	0.0539	0.9461	0.8565	0.0554	0.0461
4-5	394	76	28	356.0	0.0787	0.9213	0.8104	0.0819	0.0637
5-6	290	37	12	271.5	0.0442	0.9558	0.7466	0.0452	0.0330
6-7	241	30	8	226.0	0.0354	0.9646	0.7136	0.0360	0.0253
7-8	203	35	3	185.5	0.0162	0.9838	0.6884	0.0163	0.0111
8-9	165	43	10	143.5	0.0697	0.9303	0.6772	0.0722	0.0472
10-11	112	12	6	106.0	0.0566	0.9434	0.6300	0.0583	0.0357
11-12	94	34	7	77.0	0.0909	0.9091	0.5944	0.0952	0.0540
12-13	53	24	4	41.0	0.0976	0.9024	0.5403	0.1026	0.0527
13-14	25	11	2	19.5	0.1026	0.8974	0.4876	0.1081	0.0500
14-15	12	2	0	11.0	0.0000	1.0000	0.4376	0.0000	0.0000
15-16	10	1	0	9.5	0.0000	1.0000	0.4376	0.0000	0.0000
16-17	9	0	0	9.0	0.0000	1.0000	0.4376	0.0000	0.0000
17-18	9	0	1	9.0	0.1111	0.8889	0.4376	0.1176	0.0486
18-19	8	3	0	6.5	0.0000	1.0000	0.3890	0.0000	0.0000
19-20	5	3	2	3.5	0.5714	0.4286	0.3890	0.8000	0.2223

MATERIALS = LOW COPPER CLASS II AMALGAM ALLOYS

CODES = 10401 10402 10701 12101 10501 11201 11202

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
1	-	-	1	-	-	-	-	-	1	-	-	1	1	1	-	41	46	20.6
2	-	1	3	-	-	-	-	-	-	2	1	-	-	-	-	10	17	7.6
3	4	2	10	-	-	-	-	-	-	-	1	-	-	-	3	10	30	13.5
4	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-	19	22	9.9
5	-	-	1	-	-	-	-	-	1	1	1	-	-	-	-	25	29	13.0
6	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	3	1.3
7	1	-	-	-	-	-	-	-	-	-	-	-	1	-	2	11	15	6.7
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	6	2.7
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	0.9
10	1	-	1	-	-	-	-	-	-	-	1	-	1	-	1	2	7	3.1
11	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	4	6	2.7
12	-	1	-	-	-	-	-	-	-	-	-	-	2	1	1	12	17	7.6
13	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	3	4	1.8
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.4
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	0.9
16	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	0.9
17	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	2	0.9
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	7	3.1
19	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	4	5	2.2
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	8	4	18	-	-	-	-	-	2	4	8	1	6	3	8	161	223	
%	3.6	1.8	8.1	-	-	-	-	-	0.9	1.8	3.6	0.4	2.7	1.3	3.6	72.2	100	
%	25.0	12.5	56.3	-	-	-	-	-	6.3	13.3	26.7	3.3	20.0	10.0	26.7			

SUMMARY ANALYSIS

	NO	%
FUNCTIONAL	161	72.2
RELATED FAILURE	32	14.3
UNRELATED FAILURE	30	13.5
TOTAL	223	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

LOW COPPER CLASS II AMALGAM ALLOYS

75% Survival = 7.04 YEARS
50% Survival = 13.51 YEARS

YEARLY INTERVAL	NO. ENTERED	NO. LOST	NO. FAILED	NO. EXPOSED	PROPORTION FAILED	PROPORTION SURVIVING	CUMULATIVE SURVIVAL FUNCTION	HAZARD FUNCTION	FAILURE DENSITY FUNCTION
0-1	223	41	5	202.5	0.0247	0.9753	1.0000	0.0250	0.0247
1-2	177	10	7	172.0	0.0407	0.9593	0.9753	0.0415	0.0397
2-3	160	10	20	155.0	0.1290	0.8710	0.9356	0.1379	0.1207
3-4	130	19	3	120.5	0.0249	0.9751	0.8149	0.0252	0.0203
4-5	108	25	4	95.5	0.0419	0.9581	0.7946	0.0428	0.0333
5-6	79	2	1	78.0	0.0128	0.9872	0.7613	0.0129	0.0098
6-7	76	11	4	70.5	0.0567	0.9433	0.7516	0.0584	0.0426
7-8	61	6	0	58.0	0.0000	1.0000	0.7089	0.0000	0.0000
8-9	55	1	1	54.5	0.0183	0.9817	0.7089	0.0185	0.0130
10-11	53	2	5	52.0	0.0962	0.9038	0.6959	0.1010	0.0669
11-12	46	4	2	44.0	0.0455	0.9545	0.6290	0.0465	0.0286
12-13	40	12	5	34.0	0.1471	0.8529	0.6004	0.1587	0.0883
13-14	23	3	1	21.5	0.0465	0.9535	0.5121	0.0476	0.0238
14-15	19	1	0	18.5	0.0000	1.0000	0.4883	0.0000	0.0000
15-16	18	2	0	17.0	0.0000	1.0000	0.4883	0.0000	0.0000
16-17	16	0	2	16.0	0.1250	0.8750	0.4883	0.1333	0.0610
17-18	14	1	1	13.5	0.0741	0.9259	0.4273	0.0769	0.0316
18-19	12	7	0	8.5	0.0000	1.0000	0.3956	0.0000	0.0000
19-20	5	4	1	3.0	0.3333	0.6667	0.3956	0.4000	0.1319

MATERIALS = ALL AMALGAM ALLOYS

CODES = 10301 10302 10303 10306 10311 10401 10402 10701 11101 11201 11301 11309 12102 12104 10501 12402 10304 11302 10305 10309 10310 11102 11103 11202 11303 11306 11307 11308 12101 12103 12401

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
1	-	2	2	-	-	-	-	1	3	2	5	3	6	6	1	240	271	15.7
2	6	15	4	-	-	-	-	-	2	2	5	2	8	3	4	103	154	8.9
3	12	13	17	-	-	-	1	-	2	4	7	-	1	2	7	87	153	8.9
4	6	5	8	1	-	-	-	-	2	2	5	-	1	1	10	136	177	10.2
5	10	6	4	-	-	-	-	-	3	7	8	-	3	6	5	232	284	16.4
6	3	3	-	-	-	-	-	-	-	2	2	3	2	-	2	110	127	7.4
7	3	4	-	1	-	-	-	-	-	-	2	-	2	-	5	73	90	5.2
8	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	73	77	4.5
9	2	1	-	-	-	-	-	-	-	2	5	-	1	2	1	91	105	6.1
10	1	1	1	-	-	-	-	1	-	3	2	-	1	-	1	38	49	2.8
11	1	2	-	-	-	-	-	-	-	2	1	-	2	-	3	73	84	4.9
12	-	2	-	-	-	-	-	-	-	4	-	-	4	1	3	55	69	4.0
13	-	-	-	-	-	-	-	-	-	-	-	-	2	4	1	24	31	1.8
14	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	11	12	0.7
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	5	0.3
16	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	0.1
17	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	2	4	0.2
18	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	16	17	1.0
19	-	-	-	-	1	-	-	-	-	-	-	-	2	-	-	13	16	0.9
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	49	55	36	2	1	-	1	2	12	32	44	8	35	25	43	1382	1727	
%	2.8	3.2	2.1	0.1	0.1	-	0.1	0.1	0.7	1.9	2.5	0.5	2.0	1.4	2.5	80.0	100	
%	31.0	34.8	22.8	1.3	0.6	-	0.6	1.3	7.6	17.1	23.5	4.3	18.7	13.4	23.0			

SUMMARY ANALYSIS

	NO	%
FUNCTIONAL	1382	80.0
RELATED FAILURE	158	9.1
UNRELATED FAILURE	187	10.8
TOTAL	1727	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

ALL AMALGAM ALLOYS

75% Survival = 9.16 YEARS
50% Survival = 16.77 YEARS

YEARLY INTERVAL	NO. ENTERED	NO. LOST	NO. FAILED	NO. EXPOSED	PROPORTION FAILED	PROPORTION SURVIVING	CUMULATIVE SURVIVAL FUNCTION	HAZARD FUNCTION	FAILURE DENSITY FUNCTION
0-1	1,727	240	31	1,607.0	0.0193	0.9807	1.0000	0.0195	0.0193
1-2	1,456	103	51	1,404.5	0.0363	0.9637	0.9807	0.0370	0.0356
2-3	1,302	87	66	1,258.5	0.0524	0.9476	0.9451	0.0539	0.0496
3-4	1,149	136	41	1,081.0	0.0379	0.9621	0.8955	0.0387	0.0340
4-5	972	232	52	856.0	0.0607	0.9393	0.8616	0.0627	0.0523
5-6	688	110	17	633.0	0.0269	0.9731	0.8092	0.0272	0.0217
6-7	561	73	17	524.5	0.0324	0.9676	0.7875	0.0329	0.0255
7-8	471	73	4	434.5	0.0092	0.9908	0.7620	0.0092	0.0070
8-9	394	91	14	348.5	0.0402	0.9598	0.7550	0.0410	0.0303
10-11	289	38	11	270.0	0.0407	0.9593	0.7246	0.0416	0.0295
11-12	240	73	11	203.5	0.0541	0.9459	0.6951	0.0556	0.0376
12-13	156	55	14	128.5	0.1089	0.8911	0.6575	0.1152	0.0716
13-14	87	24	7	75.0	0.0933	0.9067	0.5859	0.0979	0.0547
14-15	56	11	1	50.5	0.0198	0.9802	0.5312	0.0200	0.0105
15-16	44	5	0	41.5	0.0000	1.0000	0.5207	0.0000	0.0000
16-17	39	0	2	39.0	0.0513	0.9487	0.5207	0.0526	0.0267
17-18	37	2	2	36.0	0.0556	0.9444	0.4940	0.0571	0.0274
18-19	33	16	1	25.0	0.0400	0.9600	0.4665	0.0408	0.0187
19-20	16	13	3	9.5	0.3158	0.6842	0.4479	0.3750	0.1414

MATERIALS = POSTERIOR COMPOSITES

CODES = 10102 10601 10803 10804 10805 10806 11401 11403 11404 12302 12303 12501 12502

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
1	1	3	1	-	1	-	-	1	6	1	2	2	2	5	1	100	126	17.5
2	9	6	8	8	5	-	1	-	3	1	2	-	-	-	4	41	88	12.3
3	12	2	7	2	-	-	-	-	2	8	-	-	2	6	-	38	79	11.0
4	20	6	4	4	4	-	-	-	1	1	1	1	-	-	3	46	91	12.7
5	8	4	-	2	5	-	-	-	6	-	3	-	1	-	15	50	94	13.1
6	5	2	-	-	-	-	-	-	-	1	-	-	-	-	2	28	38	5.3
7	7	1	-	-	2	-	-	-	1	-	1	-	1	3	2	17	35	4.9
8	6	-	-	-	4	-	-	-	-	2	-	-	-	1	3	23	39	5.4
9	2	1	-	-	5	-	-	-	-	1	1	-	-	2	2	35	49	6.8
10	1	-	-	1	-	-	-	-	-	-	-	-	1	-	-	20	23	3.2
11	2	-	-	-	1	-	-	-	-	-	-	-	-	-	1	5	9	1.3
12	1	-	-	-	-	-	-	-	-	-	-	-	-	1	2	10	14	1.9
13	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	3	5	0.7
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	10	11	1.5
15	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	9	10	1.4
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	1	-	-	-	-	-	-	-	-	-	5	1	7	1.0
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	75	25	20	17	30	-	1	1	19	15	10	3	7	18	41	436	718	
%	10.4	3.5	2.8	2.4	4.2	-	0.1	0.1	2.6	2.1	1.4	0.4	1.0	2.5	5.7	60.7	100	
%	39.9	13.3	10.6	9.0	16.0	-	0.5	0.5	10.1	16.0	10.6	3.2	7.4	19.1	43.6			

SUMMARY ANALYSIS

	NO	%
FUNCTIONAL	436	60.7
RELATED FAILURE	188	26.2
UNRELATED FAILURE	94	13.1
TOTAL	718	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

POSTERIOR COMPOSITES

75% Survival = 4.64 YEARS
50% Survival = 8.60 YEARS

YEARLY INTERVAL	*NO. ENTERED*	*NO. LOST*	*NO. FAILED*	*NO. EXPOSED*	*PROPORTION FAILED*	*PROPORTION SURVIVING*	*CUMULATIVE SURVIVAL FUNCTION*	*HAZARD FUNCTION*	*FAILURE DENSITY FUNCTION*
0-1	718	100	26	668.0	0.0389	0.9611	1.0000	0.0397	0.0389
1-2	592	41	47	571.5	0.0822	0.9178	0.9611	0.0858	0.0790
2-3	504	38	41	485.0	0.0845	0.9155	0.8820	0.0883	0.0746
3-4	425	46	45	402.0	0.1119	0.8881	0.8075	0.1186	0.0904
4-5	334	50	44	309.0	0.1424	0.8576	0.7171	0.1533	0.1021
5-6	240	28	10	226.0	0.0442	0.9558	0.6150	0.0452	0.0272
6-7	202	17	18	193.5	0.0930	0.9070	0.5878	0.0976	0.0547
7-8	167	23	16	155.5	0.1029	0.8971	0.5331	0.1085	0.0549
8-9	128	35	14	110.5	0.1267	0.8733	0.4782	0.1353	0.0606
10-11	79	20	3	69.0	0.0435	0.9565	0.4176	0.0444	0.0182
11-12	56	5	4	53.5	0.0748	0.9252	0.3995	0.0777	0.0299
12-13	47	10	4	42.0	0.0952	0.9048	0.3696	0.1000	0.0352
13-14	33	3	2	31.5	0.0635	0.9365	0.3344	0.0656	0.0212
14-15	28	10	1	23.0	0.0435	0.9565	0.3132	0.0444	0.0136
15-16	17	9	1	12.5	0.0800	0.9200	0.2996	0.0833	0.0240
16-17	7	0	0	7.0	0.0000	1.0000	0.2756	0.0000	0.0000
17-18	7	0	0	7.0	0.0000	1.0000	0.2756	0.0000	0.0000
18-19	7	1	6	6.5	0.9231	0.0769	0.2756	1.7143	0.2544
19-20	0	0	0	0.0	ERR	ERR	0.0212	ERR	ERR

MATERIALS = BASE METAL ALLOYS

CODES = 11601 11602 11603 11701 11802 11803 11804 11901 11902

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
1	-	-	-	-	-	-	-	-	-	-	6	-	-	1	-	48	55	15.1
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	11	15	4.1
3	-	9	-	-	-	-	-	-	-	-	-	-	-	-	7	11	27	7.4
4	1	-	-	-	-	-	-	-	-	-	-	-	-	2	1	17	21	5.8
5	5	-	-	-	-	-	-	4	-	-	-	-	-	-	-	49	58	15.9
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	26	7.1
7	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	23	6.3
8	2	-	-	-	-	-	-	-	-	-	-	-	1	-	3	11	17	4.7
9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	4	10	15	4.1
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	27	30	8.2
12	1	-	-	6	-	-	-	-	-	1	-	-	-	-	4	66	78	21.4
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	17	9	-	6	-	-	-	4	-	1	6	3	1	3	23	292	365	
%	4.7	2.5	-	1.6	-	-	-	1.1	-	0.3	1.6	0.8	0.3	0.8	6.3	80.0	100	
%	47.2	25.0	-	16.7	-	-	-	11.1	-	2.7	16.2	8.1	2.7	8.1	62.2			

SUMMARY ANALYSIS

	NO	%
FUNCTIONAL	292	80.0
RELATED FAILURE	36	9.9
UNRELATED FAILURE	37	10.1
TOTAL	365	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

BASE METAL ALLOYS

75% Survival = 11.15 YEARS
50% Survival = >13.0 YEARS

YEARLY INTERVAL	*NO. ENTERED*	*NO. LOST*	*NO. FAILED*	*NO. EXPOSED*	*PROPORTION FAILED*	*PROPORTION SURVIVING*	*CUMULATIVE SURVIVAL FUNCTION*	*HAZARD FUNCTION*	*FAILURE DENSITY FUNCTION*
0-1	365	48	7	341.0	0.0205	0.9795	1.0000	0.0207	0.0205
1-2	310	11	4	304.5	0.0131	0.9869	0.9795	0.0132	0.0129
2-3	295	11	16	289.5	0.0553	0.9447	0.9666	0.0568	0.0534
3-4	268	17	4	259.5	0.0154	0.9846	0.9132	0.0155	0.0141
4-5	247	49	9	222.5	0.0404	0.9596	0.8991	0.0413	0.0364
5-6	189	26	0	176.0	0.0000	1.0000	0.8627	0.0000	0.0000
6-7	163	16	7	155.0	0.0452	0.9548	0.8627	0.0462	0.0390
7-8	140	11	6	134.5	0.0446	0.9554	0.8238	0.0456	0.0367
8-9	123	10	5	118.0	0.0424	0.9576	0.7870	0.0433	0.0333
10-11	108	0	0	108.0	0.0000	1.0000	0.7537	0.0000	0.0000
11-12	108	27	3	94.5	0.0317	0.9683	0.7537	0.0323	0.0239
12-13	78	66	12	45.0	0.2667	0.7333	0.7298	0.3077	0.1946
13-14	0	0	0	0.0	ERR	ERR	0.5352	ERR	ERR
14-15	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
15-16	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
16-17	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
17-18	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
18-19	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
19-20	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR

MATERIALS = GOLD ALLOYS

CODES = 11501

YR	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	OK	TOTAL	%
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	12	11.5
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	2.9
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	5	8	7.7
4	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	3	4	3.8
5	1	-	-	-	-	-	-	-	-	-	-	-	-	2	9	22	34	32.7
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	3.8
8	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	5	6	5.8
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	6	5.8
12	1	-	-	4	-	-	-	-	-	-	-	-	-	-	-	22	27	26.0
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	6	-	-	5	-	-	-	-	-	-	-	-	1	2	12	78	104	
%	5.8	-	-	4.8	-	-	-	-	-	-	-	-	1.0	1.9	11.5	75.0	100	
%	54.5	-	-	45.5	-	-	-	-	-	-	-	-	6.7	13.3	80.0			

SUMMARY ANALYSIS

	NO	%
FUNCTIONAL	78	75.0
RELATED FAILURE	11	10.6
UNRELATED FAILURE	15	14.4
TOTAL	104	100.0

LIFE TABLE AND SURVIVAL ANALYSIS

GOLD ALLOYS

75% Survival = 11.09 YEARS
50% Survival = 12.79 YEARS

YEARLY INTERVAL	NO. ENTERED	NO. LOST	NO. FAILED	NO. EXPOSED	PROPORTION FAILED	PROPORTION SURVIVING	CUMULATIVE SURVIVAL FUNCTION	HAZARD FUNCTION	FAILURE DENSITY FUNCTION
0-1	104	12	0	98.0	0.0000	1.0000	1.0000	0.0000	0.0000
1-2	92	3	0	90.5	0.0000	1.0000	1.0000	0.0000	0.0000
2-3	89	5	3	86.5	0.0347	0.9653	1.0000	0.0353	0.0347
3-4	81	3	1	79.5	0.0126	0.9874	0.9653	0.0127	0.0121
4-5	77	22	12	66.0	0.1818	0.8182	0.9532	0.2000	0.1733
5-6	43	0	0	43.0	0.0000	1.0000	0.7799	0.0000	0.0000
6-7	43	4	0	41.0	0.0000	1.0000	0.7799	0.0000	0.0000
7-8	39	5	1	36.5	0.0274	0.9726	0.7799	0.0278	0.0214
8-9	33	0	0	33.0	0.0000	1.0000	0.7585	0.0000	0.0000
10-11	33	0	0	33.0	0.0000	1.0000	0.7585	0.0000	0.0000
11-12	33	2	4	32.0	0.1250	0.8750	0.7585	0.1333	0.0948
12-13	27	22	5	16.0	0.3125	0.6875	0.6637	0.3704	0.2074
13-14	0	0	0	0.0	ERR	ERR	0.4563	ERR	ERR
14-15	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
15-16	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
16-17	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
17-18	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
18-19	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR
19-20	0	0	0	0.0	ERR	ERR	ERR	ERR	ERR

APPENDIX 2

HERCULITE VS. DISPERSALLOY

```
05/18/88                                                                                   PAGE  1
******************************************************************************************
******************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                        ID NO. = 500249    SEX = F   RACE = C   AGE =  68

10/30/85  NO=13 HERCULITE      Roberts   ABAAA   8  ABAAA   2  ABAAA   3
          SURFACE= MOD         AGE OF RESTORATION =  31  MONTHS


12/11/85  NO=28 DISPERSALLOY   Roberts   HHAAA   8  HHAAA   3  HHAAA   3
          SURFACE= DO          AGE OF RESTORATION =  29  MONTHS


12/11/85  NO=29 HERCULITE      Roberts   ABAAA   6  ABAAA   3  ABAAA   3
          SURFACE= MOD         AGE OF RESTORATION =  29  MONTHS


12/11/85  NO=31 DISPERSALLOY   Roberts   HHAAA  10  HHAAA   8  HHAAA   8
          SURFACE= MO          AGE OF RESTORATION =  29  MONTHS

******************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                        ID NO. = 500242    SEX = F   RACE = C   AGE =  81

10/09/85  NO=04 HERCULITE      Roberts   AAAAA   2  ABAAA   4  ABAAA   3
          SURFACE= DO          AGE OF RESTORATION =  31  MONTHS


10/09/85  NO=12 DISPERSALLOY   Roberts   HHAAA   5  HHAAA   6  HHAAA   4
          SURFACE= DO          AGE OF RESTORATION =  31  MONTHS

******************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                        ID NO. = 500244    SEX = F   RACE = C   AGE =  70
```

```
******************************************************************************************
10/23/85  NO=03 HERCULITE      Roberts   AAAAA   0  BBAAA   4  BBAAA   2
          SURFACE= MOL         AGE OF RESTORATION =  31  MONTHS

10/23/85  NO=15 DISPERSALLOY   Roberts   HHAAA   8  HHABA  14 HHAAA   18
          SURFACE= MO          AGE OF RESTORATION =  31  MONTHS

******************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                ID NO. = 500264   SEX = M   RACE = C   AGE =  67

03/10/86  NO=31 HERCULITE      Roberts   ABAAA   3  ABAAA   3  ABAAA   4
          SURFACE= DO          AGE OF RESTORATION =  26  MONTHS

03/12/86  NO=30 DISPERSALLOY   Roberts   HHAAA   4  HHAAA   8  HHAAA   4
          SURFACE= MOD         AGE OF RESTORATION =  26  MONTHS

04/09/86  NO=20 HERCULITE      Roberts   AAAAA   1  AAAAA   1  Y          Y          Y          Y
          SURFACE= DI          AGE OF RESTORATION =  25  MONTHS

04/10/86  NO=19 DISPERSALLOY   Roberts   HHAAA  12 HHAAA   10 HHAAA   8
          SURFACE= MOL         AGE OF RESTORATION =  25  MONTHS

******************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                ID NO. = 500269   SEX = F   RACE = C   AGE =  66

03/12/86  NO=30 DISPERSALLOY   Roberts   HHAAA   4  HHAAA   2
          SURFACE= MOD         AGE OF RESTORATION =  26  MONTHS

04/09/86  NO=20 HERCULITE      Roberts   AAAAA   1  AAAAA   1
          SURFACE= DO          AGE OF RESTORATION =  25  MONTHS
```

COLOR MATCH

RATINGS	HERCULITE PERIOD # 0	PERIOD # 1	DISPERSALLOY PERIOD # 0	PERIOD # 1
ALPHA	42	44	0	0
BRAVO	11	8	0	0
CHARLIE	0	0	0	0
DELTA	0	0	0	0
HOTEL	0	0	55	52
========(RELATED REASONS)=========				
RELATED-CARIES (J)	0	0	0	1
RELATED FRACTURE (K)	0	0	0	0
OPEN MARGIN (L)	0	0	0	0
LEAKAGE (M)	0	0	0	0
WEAR (N)	0	0	0	0
COLOR (P)	0	0	0	0
HYPEREMIA (Q)	0	1	0	0
CONTACT/CONTOUR (R)	0	0	0	0
OTHER-RELATED (S)	0	0	0	0
=======(UNRELATED REASONS)========				
CARIES-UNRELATED (T)	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	1
ENDODONTIC TREATMENT (V)	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0
TOOTH MISSING (X)	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0
=====(PATIENT COMPLICATIONS)======				
DROPPED FROM STUDY (1)	0	0	0	0
HEALTH REASON (2)	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	1
FEDERAL SERVICE (4)	0	0	0	0
UNABLE TO CONTACT (5)	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0
NO EVALUATION RECORD	0	0	0	0
IMPROVED	0	6	0	0
NO CHANGE	0	42	0	52
DETERIORATED	0	4	0	0
STUDY TOTAL	0	52	0	52
NON-EVALUATION RELATED	0	1	0	1
NON-EVALUATION UNRELATED	0	0	0	1
NON-EVAL PTNT COMPLIC	0	0	0	1
TOTAL COUNT	0	53	0	55

COLOR MATCH

RATINGS	HERCULITE PERIOD # 0	HERCULITE PERIOD # 2	DISPERSALLOY PERIOD # 0	DISPERSALLOY PERIOD # 2
ALPHA	42	37	0	0
BRAVO	11	5	0	0
CHARLIE	0	1	0	0
DELTA	0	0	0	0
HOTEL	0	0	55	40
========(RELATED REASONS)=========				
RELATED-CARIES (J)	0	0	0	1
RELATED FRACTURE (K)	0	1	0	1
OPEN MARGIN (L)	0	0	0	0
LEAKAGE (M)	0	0	0	0
WEAR (N)	0	0	0	0
COLOR (P)	0	0	0	0
HYPEREMIA (Q)	0	1	0	0
CONTACT/CONTOUR (R)	0	0	0	0
OTHER-RELATED (S)	0	0	0	0
=======(UNRELATED REASONS)========				
CARIES-UNRELATED (T)	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	1
ENDODONTIC TREATMENT (V)	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0
TOOTH MISSING (X)	0	0	0	0
OTHER UNRELATED (Y)	0	1	0	0
=====(PATIENT COMPLICATIONS)======				
DROPPED FROM STUDY (1)	0	0	0	0
HEALTH REASON (2)	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0
UNABLE TO CONTACT (5)	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0
NO EVALUATION RECORD	0	7	0	12
IMPROVED	0	6	0	0
NO CHANGE	0	33	0	40
DETERIORATED	0	4	0	0
STUDY TOTAL	0	43	0	40
NON-EVALUATION RELATED	0	2	0	2
NON-EVALUATION UNRELATED	0	1	0	1
NON-EVAL PTNT COMPLIC	0	7	0	12
TOTAL COUNT	0	53	0	55

CAVO-SURFACE MARGINAL DISCOLORATION

RATINGS	HERCULITE PERIOD # 0	HERCULITE PERIOD # 1	DISPERSALLOY PERIOD # 0	DISPERSALLOY PERIOD # 1
ALPHA	37	26	3	1
BRAVO	16	26	0	0
CHARLIE	0	0	0	0
DELTA	0	0	0	0
HOTEL	0	0	52	51
========(RELATED REASONS)=========				
RELATED-CARIES (J)	0	0	0	1
RELATED FRACTURE (K)	0	0	0	0
OPEN MARGIN (L)	0	0	0	0
LEAKAGE (M)	0	0	0	0
WEAR (N)	0	0	0	0
COLOR (P)	0	0	0	0
HYPEREMIA (Q)	0	1	0	0
CONTACT/CONTOUR (R)	0	0	0	0
OTHER-RELATED (S)	0	0	0	0
=======(UNRELATED REASONS)========				
CARIES-UNRELATED (T)	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	1
ENDODONTIC TREATMENT (V)	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0
TOOTH MISSING (X)	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0
=====(PATIENT COMPLICATIONS)======				
DROPPED FROM STUDY (1)	0	0	0	0
HEALTH REASON (2)	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	1
FEDERAL SERVICE (4)	0	0	0	0
UNABLE TO CONTACT (5)	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0
NO EVALUATION RECORD	0	0	0	0
IMPROVED	0	4	0	1
NO CHANGE	0	34	0	48
DETERIORATED	0	14	0	3
STUDY TOTAL	0	52	0	52
NON-EVALUATION RELATED	0	1	0	1
NON-EVALUATION UNRELATED	0	0	0	1
NON-EVAL PTNT COMPLIC	0	0	0	1
TOTAL COUNT	0	53	0	55

CAVO-SURFACE MARGINAL DISCOLORATION

RATINGS	HERCULITE PERIOD # 0	HERCULITE PERIOD # 2	DISPERSALLOY PERIOD # 0	DISPERSALLOY PERIOD # 2
ALPHA	37	17	3	0
BRAVO	16	26	0	0
CHARLIE	0	0	0	0
DELTA	0	0	0	0
HOTEL	0	0	52	40
========(RELATED REASONS)=========				
RELATED-CARIES (J)	0	0	0	1
RELATED FRACTURE (K)	0	1	0	1
OPEN MARGIN (L)	0	0	0	0
LEAKAGE (M)	0	0	0	0
WEAR (N)	0	0	0	0
COLOR (P)	0	0	0	0
HYPEREMIA (Q)	0	1	0	0
CONTACT/CONTOUR (R)	0	0	0	0
OTHER-RELATED (S)	0	0	0	0
=======(UNRELATED REASONS)========				
CARIES-UNRELATED (T)	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	1
ENDODONTIC TREATMENT (V)	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0
TOOTH MISSING (X)	0	0	0	0
OTHER UNRELATED (Y)	0	1	0	0
=====(PATIENT COMPLICATIONS)======				
DROPPED FROM STUDY (1)	0	0	0	0
HEALTH REASON (2)	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0
UNABLE TO CONTACT (5)	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0
NO EVALUATION RECORD	0	7	0	12
IMPROVED	0	4	0	0
NO CHANGE	0	24	0	40
DETERIORATED	0	15	0	0
STUDY TOTAL	0	43	0	40
NON-EVALUATION RELATED	0	2	0	2
NON-EVALUATION UNRELATED	0	1	0	1
NON-EVAL PTNT COMPLIC	0	7	0	12
TOTAL COUNT	0	53	0	55

ANATOMIC FORM

RATINGS	HERCULITE PERIOD # 0	HERCULITE PERIOD # 1	DISPERSALLOY PERIOD # 0	DISPERSALLOY PERIOD # 1
ALPHA	51	47	55	50
BRAVO	2	5	0	1
CHARLIE	0	0	0	1
DELTA	0	0	0	0
HOTEL	0	0	0	0
========(RELATED REASONS)=========				
RELATED-CARIES (J)	0	0	0	1
RELATED FRACTURE (K)	0	0	0	0
OPEN MARGIN (L)	0	0	0	0
LEAKAGE (M)	0	0	0	0
WEAR (N)	0	0	0	0
COLOR (P)	0	0	0	0
HYPEREMIA (Q)	0	1	0	0
CONTACT/CONTOUR (R)	0	0	0	0
OTHER-RELATED (S)	0	0	0	0
=======(UNRELATED REASONS)========				
CARIES-UNRELATED (T)	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	1
ENDODONTIC TREATMENT (V)	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0
TOOTH MISSING (X)	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0
=====(PATIENT COMPLICATIONS)======				
DROPPED FROM STUDY (1)	0	0	0	0
HEALTH REASON (2)	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	1
FEDERAL SERVICE (4)	0	0	0	0
UNABLE TO CONTACT (5)	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0
NO EVALUATION RECORD	0	0	0	0
IMPROVED	0	0	0	0
NO CHANGE	0	49	0	50
DETERIORATED	0	3	0	2
STUDY TOTAL	0	52	0	52
NON-EVALUATION RELATED	0	1	0	1
NON-EVALUATION UNRELATED	0	0	0	1
NON-EVAL PTNT COMPLIC	0	0	0	1
TOTAL COUNT	0	53	0	55

ANATOMIC FORM

RATINGS	HERCULITE PERIOD # 0	HERCULITE PERIOD # 2	DISPERSALLOY PERIOD # 0	DISPERSALLOY PERIOD # 2
ALPHA	51	43	55	38
BRAVO	2	0	0	1
CHARLIE	0	0	0	1
DELTA	0	0	0	0
HOTEL	0	0	0	0
========(RELATED REASONS)=========				
RELATED-CARIES (J)	0	0	0	1
RELATED FRACTURE (K)	0	1	0	1
OPEN MARGIN (L)	0	0	0	0
LEAKAGE (M)	0	0	0	0
WEAR (N)	0	0	0	0
COLOR (P)	0	0	0	0
HYPEREMIA (Q)	0	1	0	0
CONTACT/CONTOUR (R)	0	0	0	0
OTHER-RELATED (S)	0	0	0	0
=======(UNRELATED REASONS)========				
CARIES-UNRELATED (T)	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	1
ENDODONTIC TREATMENT (V)	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0
TOOTH MISSING (X)	0	0	0	0
OTHER UNRELATED (Y)	0	1	0	0
=====(PATIENT COMPLICATIONS)======				
DROPPED FROM STUDY (1)	0	0	0	0
HEALTH REASON (2)	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0
UNABLE TO CONTACT (5)	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0
NO EVALUATION RECORD	0	7	0	12
IMPROVED	0	1	0	0
NO CHANGE	0	42	0	38
DETERIORATED	0	0	0	2
STUDY TOTAL	0	43	0	40
NON-EVALUATION RELATED	0	2	0	2
NON-EVALUATION UNRELATED	0	1	0	1
NON-EVAL PTNT COMPLIC	0	7	0	12
TOTAL COUNT	0	53	0	55

MARGINAL ADAPTATION

RATINGS	HERCULITE PERIOD # 0	PERIOD # 1	DISPERSALLOY PERIOD # 0	PERIOD # 1
ALPHA	51	48	54	48
BRAVO	2	4	1	3
CHARLIE	0	0	0	1
DELTA	0	0	0	0
HOTEL	0	0	0	0
========(RELATED REASONS)=========				
RELATED-CARIES (J)	0	0	0	1
RELATED FRACTURE (K)	0	0	0	0
OPEN MARGIN (L)	0	0	0	0
LEAKAGE (M)	0	0	0	0
WEAR (N)	0	0	0	0
COLOR (P)	0	0	0	0
HYPEREMIA (Q)	0	1	0	0
CONTACT/CONTOUR (R)	0	0	0	0
OTHER-RELATED (S)	0	0	0	0
=======(UNRELATED REASONS)========				
CARIES-UNRELATED (T)	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	1
ENDODONTIC TREATMENT (V)	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0
TOOTH MISSING (X)	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0
=====(PATIENT COMPLICATIONS)======				
DROPPED FROM STUDY (1)	0	0	0	0
HEALTH REASON (2)	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	1
FEDERAL SERVICE (4)	0	0	0	0
UNABLE TO CONTACT (5)	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0
NO EVALUATION RECORD	0	0	0	0
IMPROVED	0	0	0	1
NO CHANGE	0	49	0	47
DETERIORATED	0	3	0	4
STUDY TOTAL	0	52	0	52
NON-EVALUATION RELATED	0	1	0	1
NON-EVALUATION UNRELATED	0	0	0	1
NON-EVAL PTNT COMPLIC	0	0	0	1
TOTAL COUNT	0	53	0	55

MARGINAL ADAPTATION

RATINGS	HERCULITE PERIOD # 0	HERCULITE PERIOD # 2	DISPERSALLOY PERIOD # 0	DISPERSALLOY PERIOD # 2
ALPHA	51	42	54	35
BRAVO	2	1	1	4
CHARLIE	0	0	0	1
DELTA	0	0	0	0
HOTEL	0	0	0	0
========(RELATED REASONS)=========				
RELATED-CARIES (J)	0	0	0	1
RELATED FRACTURE (K)	0	1	0	1
OPEN MARGIN (L)	0	0	0	0
LEAKAGE (M)	0	0	0	0
WEAR (N)	0	0	0	0
COLOR (P)	0	0	0	0
HYPEREMIA (Q)	0	1	0	0
CONTACT/CONTOUR (R)	0	0	0	0
OTHER-RELATED (S)	0	0	0	0
=======(UNRELATED REASONS)========				
CARIES-UNRELATED (T)	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	1
ENDODONTIC TREATMENT (V)	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0
TOOTH MISSING (X)	0	0	0	0
OTHER UNRELATED (Y)	0	1	0	0
=====(PATIENT COMPLICATIONS)======				
DROPPED FROM STUDY (1)	0	0	0	0
HEALTH REASON (2)	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0
UNABLE TO CONTACT (5)	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0
NO EVALUATION RECORD	0	7	0	12
IMPROVED	0	1	0	1
NO CHANGE	0	41	0	34
DETERIORATED	0	1	0	5
STUDY TOTAL	0	43	0	40
NON-EVALUATION RELATED	0	2	0	2
NON-EVALUATION UNRELATED	0	1	0	1
NON-EVAL PTNT COMPLIC	0	7	0	12
TOTAL COUNT	0	53	0	55

CARIES

RATINGS	HERCULITE PERIOD # 0	HERCULITE PERIOD # 1	DISPERSALLOY PERIOD # 0	DISPERSALLOY PERIOD # 1
ALPHA	53	52	55	52
BRAVO	0	0	0	0
CHARLIE	0	0	0	0
DELTA	0	0	0	0
HOTEL	0	0	0	0
========(RELATED REASONS)=========				
RELATED-CARIES (J)	0	0	0	1
RELATED FRACTURE (K)	0	0	0	0
OPEN MARGIN (L)	0	0	0	0
LEAKAGE (M)	0	0	0	0
WEAR (N)	0	0	0	0
COLOR (P)	0	0	0	0
HYPEREMIA (Q)	0	1	0	0
CONTACT/CONTOUR (R)	0	0	0	0
OTHER-RELATED (S)	0	0	0	0
=======(UNRELATED REASONS)========				
CARIES-UNRELATED (T)	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	1
ENDODONTIC TREATMENT (V)	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0
TOOTH MISSING (X)	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0
=====(PATIENT COMPLICATIONS)======				
DROPPED FROM STUDY (1)	0	0	0	0
HEALTH REASON (2)	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	1
FEDERAL SERVICE (4)	0	0	0	0
UNABLE TO CONTACT (5)	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0
NO EVALUATION RECORD	0	0	0	0
IMPROVED	0	0	0	0
NO CHANGE	0	52	0	52
DETERIORATED	0	0	0	0
STUDY TOTAL	0	52	0	52
NON-EVALUATION RELATED	0	1	0	1
NON-EVALUATION UNRELATED	0	0	0	1
NON-EVAL PTNT COMPLIC	0	0	0	1
TOTAL COUNT	0	53	0	55

CARIES

RATINGS	HERCULITE PERIOD # 0	PERIOD # 2	DISPERSALLOY PERIOD # 0	PERIOD # 2
ALPHA	53	41	55	39
BRAVO	0	2	0	1
CHARLIE	0	0	0	0
DELTA	0	0	0	0
HOTEL	0	0	0	0
========(RELATED REASONS)=========				
RELATED-CARIES (J)	0	0	0	1
RELATED FRACTURE (K)	0	1	0	1
OPEN MARGIN (L)	0	0	0	0
LEAKAGE (M)	0	0	0	0
WEAR (N)	0	0	0	0
COLOR (P)	0	0	0	0
HYPEREMIA (Q)	0	1	0	0
CONTACT/CONTOUR (R)	0	0	0	0
OTHER-RELATED (S)	0	0	0	0
=======(UNRELATED REASONS)========				
CARIES-UNRELATED (T)	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	1
ENDODONTIC TREATMENT (V)	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0
TOOTH MISSING (X)	0	0	0	0
OTHER UNRELATED (Y)	0	1	0	0
=====(PATIENT COMPLICATIONS)======				
DROPPED FROM STUDY (1)	0	0	0	0
HEALTH REASON (2)	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0
UNABLE TO CONTACT (5)	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0
NO EVALUATION RECORD	0	7	0	12
IMPROVED	0	0	0	0
NO CHANGE	0	41	0	39
DETERIORATED	0	2	0	1
STUDY TOTAL	0	43	0	40
NON-EVALUATION RELATED	0	2	0	2
NON-EVALUATION UNRELATED	0	1	0	1
NON-EVAL PTNT COMPLIC	0	7	0	12
TOTAL COUNT	0	53	0	55

DISTRIBUTION OF RATINGS

CRITERIA - COLOR MATCH

	A	B	C	D	H	NOT EVALUATED RELATED	NOT EVALUATED UNRELATED	PATIENT COMPLICATIONS	TOTAL
PERIOD NO. 0									
HERCULITE	42	11	0	0	0	0	0	0	53
DISPERSALLOY	0	0	0	0	55	0	0	0	55
PERIOD NO. 1									
HERCULITE	44	8	0	0	0	1	0	0	53
DISPERSALLOY	0	0	0	0	52	1	1	1	55
PERIOD NO. 2									
HERCULITE	37	5	1	0	0	2	1	7	53
DISPERSALLOY	0	0	0	0	40	2	1	12	55

DISTRIBUTION OF RATINGS

CRITERIA - MARGINAL DISCOLORATION

	A	B	C	D	H	NOT EVALUATED RELATED	NOT EVALUATED UNRELATED	PATIENT COMPLICATIONS	TOTAL
PERIOD NO. 0									
HERCULITE	37	16	0	0	0	0	0	0	53
DISPERSALLOY	3	0	0	0	52	0	0	0	55
PERIOD NO. 1									
HERCULITE	26	26	0	0	0	1	0	0	53
DISPERSALLOY	1	0	0	0	51	1	1	1	55
PERIOD NO. 2									
HERCULITE	17	26	0	0	0	2	1	7	53
DISPERSALLOY	0	0	0	0	40	2	1	12	55

DISTRIBUTION OF RATINGS

CRITERIA - ANATOMIC FORM

	A	B	C	D	H	NOT EVALUATED RELATED	NOT EVALUATED UNRELATED	PATIENT COMPLICATIONS	TOTAL
PERIOD NO. 0									
HERCULITE	51	2	0	0	0	0	0	0	53
DISPERSALLOY	55	0	0	0	0	0	0	0	55
PERIOD NO. 1									
HERCULITE	47	5	0	0	0	1	0	0	53
DISPERSALLOY	50	1	1	0	0	1	1	1	55
PERIOD NO. 2									
HERCULITE	43	0	0	0	0	2	1	7	53
DISPERSALLOY	38	1	1	0	0	2	1	12	55

DISTRIBUTION OF RATINGS

CRITERIA - MARGINAL ADAPTATION

	A	B	C	D	H	NOT EVALUATED		PATIENT COMPLICATIONS	TOTAL
						RELATED	UNRELATED		
PERIOD NO. 0									
HERCULITE	51	2	0	0	0	0	0	0	53
DISPERSALLOY	54	1	0	0	0	0	0	0	55
PERIOD NO. 1									
HERCULITE	48	4	0	0	0	1	0	0	53
DISPERSALLOY	48	3	1	0	0	1	1	1	55
PERIOD NO. 2									
HERCULITE	42	1	0	0	0	2	1	7	53
DISPERSALLOY	35	4	1	0	0	2	1	12	55

DISTRIBUTION OF RATINGS

CRITERIA - CARIES

	A	B	C	D	H	NOT EVALUATED RELATED	NOT EVALUATED UNRELATED	PATIENT COMPLICATIONS	TOTAL
PERIOD NO. 0									
HERCULITE	53	0	0	0	0	0	0	0	53
DISPERSALLOY	55	0	0	0	0	0	0	0	55
PERIOD NO. 1									
HERCULITE	52	0	0	0	0	1	0	0	53
DISPERSALLOY	52	0	0	0	0	1	1	1	55
PERIOD NO. 2									
HERCULITE	41	2	0	0	0	2	1	7	53
DISPERSALLOY	39	1	0	0	0	2	1	12	55

APPENDIX 3

HYDROPHOBIC RESIN VS. ADAPTIC CONTROL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*****************************************************************************************
*****************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                    ID NO. = 334171   SEX = M   RACE = B   AGE =  57

09/15/86  NO=09 HYDROPHOBIC + ETCH Ellison   AAAAA     AAAAA     AAAAA     ABAAA
          SURFACE= D               AGE OF RESTORATION =  20  MONTHS

09/15/86  NO=10 ADAPTIC CONTROL    Ellison   AAAAA     AAAAA     AAAAA     AAAAA
          SURFACE= D               AGE OF RESTORATION =  20  MONTHS

09/15/86  NO=10 HYDROPHOBIC        Ellison   AAAAA     AAAAA     AAAAA     ABAAA
          SURFACE= M               AGE OF RESTORATION =  20  MONTHS

*****************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                    ID NO. = 340534   SEX = F   RACE = B   AGE =  49

03/13/87  NO=06 HYDROPHOBIC        Ellison   bAAAA     bAAAA     bAAAA
          SURFACE= M               AGE OF RESTORATION =  14  MONTHS

03/13/87  NO=08 HYDROPHOBIC + ETCH Ellison   AAAAA     AAAAA     AABAA
          SURFACE= M               AGE OF RESTORATION =  14  MONTHS

03/13/87  NO=09 ADAPTIC CONTROL    Ellison   AAAAA     AAAAA     AAAAA
          SURFACE= M               AGE OF RESTORATION =  14  MONTHS

*****************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                    ID NO. = 500331   SEX = M   RACE = C   AGE =  69

04/03/87  NO=08 HYDROPHOBIC + ETCH Ellison   bAAAA     bAAAA     bAAAA
          SURFACE= D               AGE OF RESTORATION =  13  MONTHS

04/03/87  NO=08 HYDROPHOBIC        Ellison   AAAAA     AABAA     AABAA
          SURFACE= M               AGE OF RESTORATION =  13  MONTHS

04/03/87  NO=09 ADAPTIC CONTROL    Ellison   bAAAA     bAAAA     bAAAA
          SURFACE= M               AGE OF RESTORATION =  13  MONTHS
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PATIENT'S NAME = XXXXXXXXXX                     ID NO. = 353985   SEX = M   RACE = C   AGE =  45

04/16/87  NO=08 HYDROPHOBIC           Ellison   AAAAA      5           ABAAA
          SURFACE= D                  AGE OF RESTORATION =  13  MONTHS

04/16/87  NO=08 ADAPTIC CONTROL       Ellison   AAAAA      5           AAAAA
          SURFACE= M                  AGE OF RESTORATION =  13  MONTHS

04/16/87  NO=09 HYDROPHOBIC + ETCH Ellison   AAAAA      5           ABAAA
          SURFACE= M                  AGE OF RESTORATION =  13  MONTHS

********************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                     ID NO. = 500179   SEX = F   RACE = C   AGE =  60

04/30/87  NO=09 ADAPTIC CONTROL       Ellison   bAAAA      bABAA       bABAA
          SURFACE= D                  AGE OF RESTORATION =  13  MONTHS

04/30/87  NO=10 HYDROPHOBIC + ETCH Ellison   bAAAA      bAAAA       bAAAA
          SURFACE= D                  AGE OF RESTORATION =  13  MONTHS

04/30/87  NO=10 HYDROPHOBIC           Ellison   bAAAA      bAAAA       bAAAA
          SURFACE= M                  AGE OF RESTORATION =  13  MONTHS

********************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                     ID NO. = 500222   SEX = M   RACE = C   AGE =  56

09/11/86  NO=08 HYDROPHOBIC + ETCH Ellison   AAAAA      AAAAA       AAAAA
          SURFACE= D                  AGE OF RESTORATION =  20  MONTHS

09/11/86  NO=09 ADAPTIC CONTROL       Ellison   AAAAA      AAAAA       AAAAA
          SURFACE= D                  AGE OF RESTORATION =  20  MONTHS
```

TOTAL NUMBER OF PATIENTS = 50

TOTAL NUMBER OF RESTORATIONS = 150

MEAN AGE OF RESTORATIONS = 18.9 MONTHS

MEAN PATIENT AGE = 54.7

TOTAL NUMBER OF MALE PATIENTS = 31

TOTAL NUMBER OF FEMALE PATIENTS = 19

TOTAL NUMBER OF ASIAN PATIENTS = 4

TOTAL NUMBER OF BLACK PATIENTS = 4

TOTAL NUMBER OF CAUCASIAN PATIENTS = 42

TOTAL NUMBER OF HISPANIC PATIENTS = 0

DISTRIBRUTION OF RESTORATIONS PER TOOTH

MATERIALS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	TOTAL
HYDROPHOBIC	-	-	-	-	-	4	5	15	5	14	1	-	-	-	-	-	-	-	-	-	-	1	2	-	1	1	1	-	-	-	-	-	50
HYDRO+ETCH	-	-	-	-	-	1	9	5	15	10	3	-	-	-	-	-	-	-	-	-	-	1	-	2	1	3	1	-	-	-	-	-	50
ADAPTIC	-	-	-	-	-	-	11	4	14	10	3	-	-	-	-	-	-	-	-	-	-	-	1	1	1	2	3	-	-	-	-	-	50
TOTAL	-	-	-	-	-	5	25	24	34	34	7	-	-	-	-	-	-	-	-	-	-	2	3	3	3	6	5	-	-	-	-	-	150

(Column header group: TEETH NUMBERS)

DISTRIBUTION OF ANTERIOR & POSTERIOR RESTORATIONS

	ANTERIOR	POSTERIOR PREMOLARS	POSTERIOR MOLARS
HYDROPHOBIC	50	0	0
HYDRO+ETCH	51	0	0
PFM CONTROL	50	0	0
TOTAL	151	0	0

COLOR MATCH

	HYDROPHOBIC PERIOD # 0	HYDROPHOBIC PERIOD # 1	HYDROPHOBIC-ETCH PERIOD # 0	HYDROPHOBIC-ETCH PERIOD # 1	ADAPTIC CONTROL PERIOD # 0	ADAPTIC CONTROL PERIOD # 1
ALPHA	39	38	38	37	31	30
BRAVO	11	11	12	12	19	19
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
RELATED-CARIES (J)	0	0	0	0	0	0
RELATED FRACTURE (K)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
LEAKAGE (M)	0	0	0	0	0	0
WEAR (N)	0	0	0	0	0	0
COLOR (P)	0	0	0	0	0	0
HYPEREMIA (Q)	0	0	0	0	0	0
CONTACT/CONTOUR (R)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	0	0	0
ENDODONTIC TREATMENT (V)	0	0	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	1	0	1	0	1
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	49	0	49	0	49
DETERIORATED	0	0	0	0	0	0
STUDY TOTAL	0	49	0	49	0	49
NON-EVALUATION RELATED	0	0	0	0	0	0
NON-EVALUATION UNRELATED	0	0	0	0	0	0
NON-EVAL PTNT COMPLIC	0	1	0	1	0	1
TOTAL COUNT	0	50	0	50	0	50

COLOR MATCH

	HYDROPHOBIC		HYDROPHOBIC-ETCH		ADAPTIC CONTROL	
	PERIOD # 0	PERIOD # 2	PERIOD # 0	PERIOD # 2	PERIOD # 0	PERIOD # 2
ALPHA	39	37	38	35	31	28
BRAVO	11	9	12	11	19	18
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
RELATED-CARIES (J)	0	0	0	0	0	0
RELATED FRACTURE (K)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
LEAKAGE (M)	0	0	0	0	0	0
WEAR (N)	0	0	0	0	0	0
COLOR (P)	0	0	0	0	0	0
HYPEREMIA (Q)	0	0	0	0	0	0
CONTACT/CONTOUR (R)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	0	0	0
ENDODONTIC TREATMENT (V)	0	0	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	1	0	1	0	1
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	3	0	3	0	3
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	46	0	46	0	46
DETERIORATED	0	0	0	0	0	0
STUDY TOTAL	0	46	0	46	0	46
NON-EVALUATION RELATED	0	0	0	0	0	0
NON-EVALUATION UNRELATED	0	0	0	0	0	0
NON-EVAL PTNT COMPLIC	0	4	0	4	0	4
TOTAL COUNT	0	50	0	50	0	50

CAVO-SURFACE MARGINAL DISCOLORATION

	HYDROPHOBIC PERIOD # 0	PERIOD # 1	HYDROPHOBIC-ETCH PERIOD # 0	PERIOD # 1	ADAPTIC CONTROL PERIOD # 0	PERIOD # 1
ALPHA	49	40	49	47	49	47
BRAVO	1	9	0	1	0	0
CHARLIE	0	0	1	1	1	2
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
RELATED-CARIES (J)	0	0	0	0	0	0
RELATED FRACTURE (K)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
LEAKAGE (M)	0	0	0	0	0	0
WEAR (N)	0	0	0	0	0	0
COLOR (P)	0	0	0	0	0	0
HYPEREMIA (Q)	0	0	0	0	0	0
CONTACT/CONTOUR (R)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	0	0	0
ENDODONTIC TREATMENT (V)	0	0	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	1	0	1	0	1
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	41	0	48	0	48
DETERIORATED	0	8	0	1	0	1
STUDY TOTAL	0	49	0	49	0	49
NON-EVALUATION RELATED	0	0	0	0	0	0
NON-EVALUATION UNRELATED	0	0	0	0	0	0
NON-EVAL PTNT COMPLIC	0	1	0	1	0	1
TOTAL COUNT	0	50	0	50	0	50

CAVO-SURFACE MARGINAL DISCOLORATION

	HYDROPHOBIC		HYDROPHOBIC-ETCH		ADAPTIC CONTROL	
	PERIOD # 0	PERIOD # 2	PERIOD # 0	PERIOD # 2	PERIOD # 0	PERIOD # 2
ALPHA	49	32	49	42	49	42
BRAVO	1	14	0	3	0	3
CHARLIE	0	0	1	1	1	1
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
RELATED-CARIES (J)	0	0	0	0	0	0
RELATED FRACTURE (K)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
LEAKAGE (M)	0	0	0	0	0	0
WEAR (N)	0	0	0	0	0	0
COLOR (P)	0	0	0	0	0	0
HYPEREMIA (Q)	0	0	0	0	0	0
CONTACT/CONTOUR (R)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	0	0	0
ENDODONTIC TREATMENT (V)	0	0	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	1	0	1	0	1
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	3	0	3	0	3
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	33	0	43	0	43
DETERIORATED	0	13	0	3	0	3
STUDY TOTAL	0	46	0	46	0	46
NON-EVALUATION RELATED	0	0	0	0	0	0
NON-EVALUATION UNRELATED	0	0	0	0	0	0
NON-EVAL PTNT COMPLIC	0	4	0	4	0	4
TOTAL COUNT	0	50	0	50	0	50

ANATOMIC FORM

	HYDROPHOBIC		HYDROPHOBIC-ETCH		ADAPTIC CONTROL	
	PERIOD # 0	PERIOD # 1	PERIOD # 0	PERIOD # 1	PERIOD # 0	PERIOD # 1
ALPHA	49	43	49	44	49	46
BRAVO	1	6	1	5	1	3
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
RELATED-CARIES (J)	0	0	0	0	0	0
RELATED FRACTURE (K)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
LEAKAGE (M)	0	0	0	0	0	0
WEAR (N)	0	0	0	0	0	0
COLOR (P)	0	0	0	0	0	0
HYPEREMIA (Q)	0	0	0	0	0	0
CONTACT/CONTOUR (R)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	0	0	0
ENDODONTIC TREATMENT (V)	0	0	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	1	0	1	0	1
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	44	0	45	0	47
DETERIORATED	0	5	0	4	0	2
STUDY TOTAL	0	49	0	49	0	49
NON-EVALUATION RELATED	0	0	0	0	0	0
NON-EVALUATION UNRELATED	0	0	0	0	0	0
NON-EVAL PTNT COMPLIC	0	1	0	1	0	1
TOTAL COUNT	0	50	0	50	0	50

ANATOMIC FORM

	HYDROPHOBIC		HYDROPHOBIC-ETCH		ADAPTIC CONTROL	
	PERIOD # 0	PERIOD # 2	PERIOD # 0	PERIOD # 2	PERIOD # 0	PERIOD # 2
ALPHA	49	34	49	37	49	44
BRAVO	1	12	1	9	1	2
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
RELATED-CARIES (J)	0	0	0	0	0	0
RELATED FRACTURE (K)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
LEAKAGE (M)	0	0	0	0	0	0
WEAR (N)	0	0	0	0	0	0
COLOR (P)	0	0	0	0	0	0
HYPEREMIA (Q)	0	0	0	0	0	0
CONTACT/CONTOUR (R)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	0	0	0
ENDODONTIC TREATMENT (V)	0	0	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	1	0	1	0	1
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	3	0	3	0	3
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	34	0	38	0	45
DETERIORATED	0	12	0	8	0	1
STUDY TOTAL	0	46	0	46	0	46
NON-EVALUATION RELATED	0	0	0	0	0	0
NON-EVALUATION UNRELATED	0	0	0	0	0	0
NON-EVAL PTNT COMPLIC	0	4	0	4	0	4
TOTAL COUNT	0	50	0	50	0	50

MARGINAL ADAPTATION

	HYDROPHOBIC		HYDROPHOBIC-ETCH		ADAPTIC CONTROL	
	PERIOD # 0	PERIOD # 1	PERIOD # 0	PERIOD # 1	PERIOD # 0	PERIOD # 1
ALPHA	48	47	50	48	49	48
BRAVO	2	2	0	1	1	1
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
RELATED-CARIES (J)	0	0	0	0	0	0
RELATED FRACTURE (K)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
LEAKAGE (M)	0	0	0	0	0	0
WEAR (N)	0	0	0	0	0	0
COLOR (P)	0	0	0	0	0	0
HYPEREMIA (Q)	0	0	0	0	0	0
CONTACT/CONTOUR (R)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	0	0	0
ENDODONTIC TREATMENT (V)	0	0	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	1	0	1	0	1
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	49	0	48	0	49
DETERIORATED	0	0	0	1	0	0
STUDY TOTAL	0	49	0	49	0	49
NON-EVALUATION RELATED	0	0	0	0	0	0
NON-EVALUATION UNRELATED	0	0	0	0	0	0
NON-EVAL PTNT COMPLIC	0	1	0	1	0	1
TOTAL COUNT	0	50	0	50	0	50

MARGINAL ADAPTATION

	HYDROPHOBIC		HYDROPHOBIC-ETCH		ADAPTIC CONTROL	
	PERIOD # 0	PERIOD # 2	PERIOD # 0	PERIOD # 2	PERIOD # 0	PERIOD # 2
ALPHA	48	43	50	45	49	45
BRAVO	2	3	0	1	1	1
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
RELATED-CARIES (J)	0	0	0	0	0	0
RELATED FRACTURE (K)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
LEAKAGE (M)	0	0	0	0	0	0
WEAR (N)	0	0	0	0	0	0
COLOR (P)	0	0	0	0	0	0
HYPEREMIA (Q)	0	0	0	0	0	0
CONTACT/CONTOUR (R)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	0	0	0
ENDODONTIC TREATMENT (V)	0	0	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	1	0	1	0	1
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	3	0	3	0	3
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	45	0	45	0	45
DETERIORATED	0	1	0	1	0	1
STUDY TOTAL	0	46	0	46	0	46
NON-EVALUATION RELATED	0	0	0	0	0	0
NON-EVALUATION UNRELATED	0	0	0	0	0	0
NON-EVAL PTNT COMPLIC	0	4	0	4	0	4
TOTAL COUNT	0	50	0	50	0	50

CARIES

	HYDROPHOBIC PERIOD # 0	PERIOD # 1	HYDROPHOBIC-ETCH PERIOD # 0	PERIOD # 1	ADAPTIC CONTROL PERIOD # 0	PERIOD # 1
ALPHA	50	49	50	49	50	49
BRAVO	0	0	0	0	0	0
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
RELATED-CARIES (J)	0	0	0	0	0	0
RELATED FRACTURE (K)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
LEAKAGE (M)	0	0	0	0	0	0
WEAR (N)	0	0	0	0	0	0
COLOR (P)	0	0	0	0	0	0
HYPEREMIA (Q)	0	0	0	0	0	0
CONTACT/CONTOUR (R)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	0	0	0
ENDODONTIC TREATMENT (V)	0	0	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	1	0	1	0	1
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	49	0	49	0	49
DETERIORATED	0	0	0	0	0	0
STUDY TOTAL	0	49	0	49	0	49
NON-EVALUATION RELATED	0	0	0	0	0	0
NON-EVALUATION UNRELATED	0	0	0	0	0	0
NON-EVAL PTNT COMPLIC	0	1	0	1	0	1
TOTAL COUNT	0	50	0	50	0	50

CARIES

	HYDROPHOBIC		HYDROPHOBIC-ETCH		ADAPTIC CONTROL	
	PERIOD # 0	PERIOD # 2	PERIOD # 0	PERIOD # 2	PERIOD # 0	PERIOD # 2
ALPHA	50	46	50	46	50	46
BRAVO	0	0	0	0	0	0
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
RELATED-CARIES (J)	0	0	0	0	0	0
RELATED FRACTURE (K)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
LEAKAGE (M)	0	0	0	0	0	0
WEAR (N)	0	0	0	0	0	0
COLOR (P)	0	0	0	0	0	0
HYPEREMIA (Q)	0	0	0	0	0	0
CONTACT/CONTOUR (R)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURE-UNRELATED (U)	0	0	0	0	0	0
ENDODONTIC TREATMENT (V)	0	0	0	0	0	0
CROWN & BRIDGE (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	1	0	1	0	1
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	3	0	3	0	3
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	46	0	46	0	46
DETERIORATED	0	0	0	0	0	0
STUDY TOTAL	0	46	0	46	0	46
NON-EVALUATION RELATED	0	0	0	0	0	0
NON-EVALUATION UNRELATED	0	0	0	0	0	0
NON-EVAL PTNT COMPLIC	0	4	0	4	0	4
TOTAL COUNT	0	50	0	50	0	50

DISTRIBUTION OF RATINGS

CRITERIA - COLOR MATCH

	A	B	C	D	H	NOT EVALUATED RELATED	NOT EVALUATED UNRELATED	PATIENT COMPLICATIONS	TOTAL
PERIOD NO. 0									
HYDROPHOBIC	39	11	0	0	0	0	0	0	50
HYDROPHOBIC-ETCH	38	12	0	0	0	0	0	0	50
ADAPTIC CONTROL	31	19	0	0	0	0	0	0	50
PERIOD NO. 1									
HYDROPHOBIC	38	11	0	0	0	0	0	1	50
HYDROPHOBIC-ETCH	37	12	0	0	0	0	0	1	50
ADAPTIC CONTROL	30	19	0	0	0	0	0	1	50
PERIOD NO. 2									
HYDROPHOBIC	37	9	0	0	0	0	0	4	50
HYDROPHOBIC-ETCH	35	11	0	0	0	0	0	4	50
ADAPTIC CONTROL	28	18	0	0	0	0	0	4	50

DISTRIBUTION OF RATINGS

CRITERIA - MARGINAL DISCOLORATION

	A	B	C	D	H	NOT EVALUATED RELATED	NOT EVALUATED UNRELATED	PATIENT COMPLICATIONS	TOTAL
PERIOD NO. 0									
HYDROPHOBIC	49	1	0	0	0	0	0	0	50
HYDROPHOBIC-ETCH	49	0	1	0	0	0	0	0	50
ADAPTIC CONTROL	49	0	1	0	0	0	0	0	50
PERIOD NO. 1									
HYDROPHOBIC	40	9	0	0	0	0	0	1	50
HYDROPHOBIC-ETCH	47	1	1	0	0	0	0	1	50
ADAPTIC CONTROL	47	0	2	0	0	0	0	1	50
PERIOD NO. 2									
HYDROPHOBIC	32	14	0	0	0	0	0	4	50
HYDROPHOBIC-ETCH	42	3	1	0	0	0	0	4	50
ADAPTIC CONTROL	42	3	1	0	0	0	0	4	50

DISTRIBUTION OF RATINGS

CRITERIA - ANATOMIC FORM

	A	B	C	D	H	NOT EVALUATED RELATED	NOT EVALUATED UNRELATED	PATIENT COMPLICATIONS	TOTAL
PERIOD NO. 0									
HYDROPHOBIC	49	1	0	0	0	C	0	0	50
HYDROPHOBIC-ETCH	49	1	0	0	0	0	0	0	50
ADAPTIC CONTROL	49	1	0	0	0	0	0	0	50
PERIOD NO. 1									
HYDROPHOBIC	43	6	0	0	0	0	0	1	50
HYDROPHOBIC-ETCH	44	5	0	0	0	0	0	1	50
ADAPTIC CONTROL	46	3	0	0	0	0	0	1	50
PERIOD NO. 2									
HYDROPHOBIC	34	12	0	0	0	0	0	4	50
HYDROPHOBIC-ETCH	37	9	0	0	0	0	0	4	50
ADAPTIC CONTROL	44	2	0	0	0	0	0	4	50

DISTRIBUTION OF RATINGS

CRITERIA - MARGINAL ADAPTATION

	A	B	C	D	H	NOT EVALUATED RELATED	NOT EVALUATED UNRELATED	PATIENT COMPLICATIONS	TOTAL
PERIOD NO. 0									
HYDROPHOBIC	48	2	0	0	0	0	0	0	50
HYDROPHOBIC-ETCH	50	0	0	0	0	0	0	0	50
ADAPTIC CONTROL	49	1	0	0	0	0	0	0	50
PERIOD NO. 1									
HYDROPHOBIC	47	2	0	0	0	0	0	1	50
HYDROPHOBIC-ETCH	48	1	0	0	0	0	0	1	50
ADAPTIC CONTROL	48	1	0	0	0	0	0	1	50
PERIOD NO. 2									
HYDROPHOBIC	43	3	0	0	0	0	0	4	50
HYDROPHOBIC-ETCH	45	1	0	0	0	0	0	4	50
ADAPTIC CONTROL	45	1	0	0	0	0	0	4	50

DISTRIBUTION OF RATINGS

CRITERIA - CARIES

	A	B	C	D	H	NOT EVALUATED RELATED	NOT EVALUATED UNRELATED	PATIENT COMPLICATIONS	TOTAL
PERIOD NO. 0									
HYDROPHOBIC	50	0	0	0	0	0	0	0	50
HYDROPHOBIC-ETCH	50	0	0	0	0	0	0	0	50
ADAPTIC CONTROL	50	0	0	0	0	0	0	0	50
PERIOD NO. 1									
HYDROPHOBIC	49	0	0	0	0	0	0	1	50
HYDROPHOBIC-ETCH	49	0	0	0	0	0	0	1	50
ADAPTIC CONTROL	49	0	0	0	0	0	0	1	50
PERIOD NO. 2									
HYDROPHOBIC	46	0	0	0	0	0	0	4	50
HYDROPHOBIC-ETCH	46	0	0	0	0	0	0	4	50
ADAPTIC CONTROL	46	0	0	0	0	0	0	4	50

DISTRIBUTION OF CHANGES

CRITERIA - COLOR MATCH

MATERIAL NO.1 = HYDROPHOBIC
MATERIAL NO.2 = HYDROPHOBIC-ETCH
MATERIAL NO.3 = ADAPTIC CONTROL
MATERIAL NO.4 =
MATERIAL NO.5 =

CHANGE FROM PERIOD 0 TO PERIOD 1	RESTORATIVE MATERIALS NO.1	NO.2	NO.3	NO.4
IMPROVED--------	0	0	0	0
DETERIORATED--------	0	0	0	0
NO CHANGE--------	49	49	49	0

CHANGE FROM PERIOD 0 TO PERIOD 2	RESTORATIVE MATERIALS NO.1	NO.2	NO.3	NO.4
IMPROVED--------	0	0	0	0
DETERIORATED--------	0	0	0	0
NO CHANGE--------	46	46	46	0

DISTRIBUTION OF CHANGES

CRITERIA - MARGINAL DISCOLORATION

MATERIAL NO.1 = HYDROPHOBIC
MATERIAL NO.2 = HYDROPHOBIC-ETCH
MATERIAL NO.3 = ADAPTIC CONTROL
MATERIAL NO.4 =
MATERIAL NO.5 =

CHANGE FROM PERIOD 0 TO PERIOD 1

	RESTORATIVE MATERIALS NO.1	NO.2	NO.3	NO.4
IMPROVED--------	0	0	0	0
DETERIORATED--------	8	1	1	0
NO CHANGE--------	41	48	48	0

CHANGE FROM PERIOD 0 TO PERIOD 2

	RESTORATIVE MATERIALS NO.1	NO.2	NO.3	NO.4
IMPROVED--------	0	0	0	0
DETERIORATED--------	13	3	3	0
NO CHANGE--------	33	43	43	0

DISTRIBUTION OF CHANGES

CRITERIA - ANATOMIC FORM

MATERIAL NO.1 = HYDROPHOBIC
MATERIAL NO.2 = HYDROPHOBIC-ETCH
MATERIAL NO.3 = ADAPTIC CONTROL
MATERIAL NO.4 =
MATERIAL NO.5 =

CHANGE FROM PERIOD 0 TO PERIOD 1	RESTORATIVE MATERIALS NO.1	NO.2	NO.3	NO.4
IMPROVED--------	0	0	0	0
DETERIORATED--------	5	4	2	0
NO CHANGE--------	44	45	47	0

CHANGE FROM PERIOD 0 TO PERIOD 2	RESTORATIVE MATERIALS NO.1	NO.2	NO.3	NO.4
IMPROVED--------	0	0	0	0
DETERIORATED--------	12	8	1	0
NO CHANGE--------	34	38	45	0

DISTRIBUTION OF CHANGES

CRITERIA - MARGINAL ADAPTATION

MATERIAL NO.1 = HYDROPHOBIC
MATERIAL NO.2 = HYDROPHOBIC-ETCH
MATERIAL NO.3 = ADAPTIC CONTROL
MATERIAL NO.4 =
MATERIAL NO.5 =

CHANGE FROM PERIOD 0 TO PERIOD 1	RESTORATIVE MATERIALS NO.1	NO.2	NO.3	NO.4
IMPROVED--------	0	0	0	0
DETERIORATED--------	0	1	0	0
NO CHANGE--------	49	48	49	0

CHANGE FROM PERIOD 0 TO PERIOD 2	RESTORATIVE MATERIALS NO.1	NO.2	NO.3	NO.4
IMPROVED--------	0	0	0	0
DETERIORATED--------	1	1	1	0
NO CHANGE--------	45	45	45	0

DISTRIBUTION OF CHANGES

CRITERIA - CARIES

MATERIAL NO.1 = HYDROPHOBIC
MATERIAL NO.2 = HYDROPHOBIC-ETCH
MATERIAL NO.3 = ADAPTIC CONTROL
MATERIAL NO.4 =
MATERIAL NO.5 =

CHANGE FROM PERIOD 0 TO PERIOD 1	RESTORATIVE MATERIALS NO.1	NO.2	NO.3	NO.4
IMPROVED--------	0	0	0	0
DETERIORATED--------	0	0	0	0
NO CHANGE--------	49	49	49	0

CHANGE FROM PERIOD 0 TO PERIOD 2	RESTORATIVE MATERIALS NO.1	NO.2	NO.3	NO.4
IMPROVED--------	0	0	0	0
DETERIORATED--------	0	0	0	0
NO CHANGE--------	46	46	46	0

CAST CERAMIC VS. PFM CONTROL


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*************************************************************************************
*************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                 ID NO. = 353985    SEX = M   RACE = C   AGE =  45

                       Crown Length =  7.3                    Mesial, Center =  2.2
        Incisal Edge/Occlusal Pit, Min. =  1.1                    Distal, Center =  1.9
                     Facial, Center =  1.2             Functional Area, Max. =  1.6
                    Lingual, Center =  1.1             Functional Area, Min. =  1.1

09/09/83  NO=13 CAST CERAMIC       Ellison  ABAAA     ABAAA     ABAAA     R         R         R
          SURFACE= CROWN           AGE OF RESTORATION =  14  MONTHS   DATE OF REPLACEMENT = 11/26/84

*************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                 ID NO. = 367877    SEX = M   RACE = C   AGE =  40

                       Crown Length =  6.1                    Mesial, Center =  2.0
        Incisal Edge/Occlusal Pit, Min. =  1.4                    Distal, Center =  1.7
                     Facial, Center =  1.4             Functional Area, Max. =  2.5
                    Lingual, Center =  1.5             Functional Area, Min. =  1.7

02/19/37  NO=30 MOLAR CAST CERAMIC Lugassy  AAAAA     AAABA     AAAAA
          SURFACE= CROWN           AGE OF RESTORATION =  15  MONTHS

*************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                 ID NO. = 500179    SEX = F   RACE = C   AGE =  60

                       Crown Length =  6.1                    Mesial, Center =  1.7
        Incisal Edge/Occlusal Pit, Min. =  1.2                    Distal, Center =  1.4
                     Facial, Center =  0.8             Functional Area, Max. =  2.1
                    Lingual, Center =  1.3             Functional Area, Min. =  1.2

02/17/84  NO=13 CAST CERAMIC       Ellison  BAAAA     BAAAA     BAAAA     BAAAA     BAAAA     BAAAA
          SURFACE= CROWN           AGE OF RESTORATION =  51  MONTHS

                       Crown Length =  5.2                    Mesial, Center =  2.1
```

```
*****************************************************************************************
          Incisal Edge/Occlusal Pit, Min. =  1.0             Distal, Center =  1.5
                          Facial, Center =  1.0     Functional Area, Max. =  1.7
                         Lingual, Center =  1.6     Functional Area, Min. =  1.1

08/29/84  NO=30 CAST CERAMIC      Ellison   BAAAA    BAAAA    BAAAA    R        R        R
          SURFACE= CROWN          AGE OF RESTORATION =  21  MONTHS   DATE OF REPLACEMENT = 05/14/86

*****************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                  ID NO. = 500222    SEX = M   RACE = C   AGE =  56

                           Crown Length =  6.0              Mesial, Center =  2.7
          Incisal Edge/Occlusal Pit, Min. =  1.6             Distal, Center =  1.8
                          Facial, Center =  1.5     Functional Area, Max. =  2.4
                         Lingual, Center =  1.9     Functional Area, Min. =  1.8

07/31/86  NO=30 MOLAR CAST CERAMIC Lugassy  AAAAB    AAAAB    AAAAB
          SURFACE= CROWN          AGE OF RESTORATION =  22  MONTHS

*****************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                  ID NO. = 364886    SEX = M   RACE = C   AGE =  32

                           Crown Length =  6.0              Mesial, Center =  1.7
          Incisal Edge/Occlusal Pit, Min. =  1.1             Distal, Center =  1.6
                          Facial, Center =  1.1     Functional Area, Max. =  2.0
                         Lingual, Center =  1.1     Functional Area, Min. =  1.0

12/22/83  NO=14 CAST CERAMIC      Ellison   BAAAA    BAAAA    BAAAA    BAAAA    BAAAA    BAAAA
          SURFACE= CROWN          AGE OF RESTORATION =  53  MONTHS

*****************************************************************************************

PATIENT'S NAME = XXXXXXXXXX                  ID NO. = 500239    SEX = F   RACE = C   AGE =  38

                           Crown Length =  5.8              Mesial, Center =  2.3
          Incisal Edge/Occlusal Pit, Min. =  1.3             Distal, Center =  2.0
```

TOTAL NUMBER OF PATIENTS =	88	
TOTAL NUMBER OF RESTORATIONS =	126	
MEAN AGE OF RESTORATIONS =	42.5	MONTHS
MEAN PATIENT AGE =	52.4	
TOTAL NUMBER OF MALE PATIENTS =	57	
TOTAL NUMBER OF FEMALE PATIENTS =	31	
TOTAL NUMBER OF ASIAN PATIENTS =	10	
TOTAL NUMBER OF BLACK PATIENTS =	6	
TOTAL NUMBER OF CAUCASIAN PATIENTS =	69	
TOTAL NUMBER OF HISPANIC PATIENTS =	3	

DISTRIBUTION OF RESTORATIONS PER TOOTH

MATERIALS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	TOTAL
	TEETH NUMBERS																																
CAST CERAMIC	-	-	4	9	5	-	8	7	9	5	-	3	10	5	-	-	-	-	3	4	2	-	-	-	-	-	-	-	1	4	1	-	80
MOLAR CAST CER.	-	1	1	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	10	-	-	20
PFM CONTROL	-	-	2	3	1	-	1	2	2	1	1	2	2	1	-	-	-	-	3	-	-	-	-	-	1	-	-	2	2	-	-	-	26
TOTAL	-	1	7	12	6	-	9	9	11	6	1	5	12	9	-	-	-	-	11	4	2	-	-	-	1	-	-	2	3	14	1	-	126

DISTRIBUTION OF ANTERIOR & POSTERIOR RESTORATIONS

	ANTERIOR	POSTERIOR	
		PREMOLARS	MOLARS
CAST CERAMIC	29	34	17
MOLAR CAST CER.	0	0	20
PFM CONTROL	8	12	6
TOTAL	37	46	43

MARGINAL ADAPTATION

	CAST CERAM PERIOD # 0	PERIOD # 1	MOLAR CAST CERAM PERIOD # 0	PERIOD # 1	PFM CONTROL PERIOD # 0	PERIOD # 1
ALPHA	47	46	18	18	10	10
BRAVO	28	28	2	2	5	5
CHARLIE	5	5	0	0	11	11
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	0	0	0	0	0
STRUCTURE FAILURE (R)	0	1	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	0	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	0	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	79	0	20	0	26
DETERIORATED	0	0	0	0	0	0
STUDY TOTAL	0	79	0	20	0	26
NON-EVALUATION RELATED	0	1	0	0	0	0
NON-EVALUATION UNRELATED	0	0	0	0	0	0
NON-EVAL PATIENT COMPLIC	0	0	0	0	0	0
TOTAL COUNT	0	80	0	20	0	26

MARGINAL ADAPTATION

	CAST CERAM PERIOD # 0	PERIOD # 2	MOLAR CAST CERAM PERIOD # 0	PERIOD # 2	PFM CONTROL PERIOD # 0	PERIOD # 2
ALPHA	47	42	18	18	10	10
BRAVO	28	26	2	2	5	5
CHARLIE	5	4	0	0	11	11
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	0	0	0	0	0
STRUCTURE FAILURE (R)	0	4	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	2	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	2	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	72	0	20	0	26
DETERIORATED	0	0	0	0	0	0
STUDY TOTAL	0	72	0	20	0	26
NON-EVALUATION RELATED	0	4	0	0	0	0
NON-EVALUATION UNRELATED	0	2	0	0	0	0
NON-EVAL PATIENT COMPLIC	0	2	0	0	0	0
TOTAL COUNT	0	80	0	20	0	26

MARGINAL ADAPTATION

	CAST CERAM PERIOD # 0	PERIOD # 3	MOLAR CAST CERAM PERIOD # 0	PERIOD # 3	PFM CONTROL PERIOD # 0	PERIOD # 3
ALPHA	47	39	18	4	10	9
BRAVO	28	24	2	1	5	5
CHARLIE	5	3	0	0	11	11
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	0	0	0	0	0
STRUCTURE FAILURE (R)	0	7	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	3	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	1
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	2	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	2	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	15	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	66	0	5	0	25
DETERIORATED	0	0	0	0	0	0
STUDY TOTAL	0	66	0	5	0	25
NON-EVALUATION RELATED	0	7	0	0	0	0
NON-EVALUATION UNRELATED	0	3	0	0	0	1
NON-EVAL PATIENT COMPLIC	0	4	0	15	0	0
TOTAL COUNT	0	80	0	20	0	26

MARGINAL ADAPTATION

	CAST CERAM		MOLAR CAST CERAM		PFM CONTROL	
	PERIOD # 0	PERIOD # 4	PERIOD # 0	PERIOD # 4	PERIOD # 0	PERIOD # 4
ALPHA	47	36	18	0	10	9
BRAVO	28	21	2	0	5	5
CHARLIE	5	3	0	0	11	11
DELTA	0	1	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	1	0	0	0	0
STRUCTURE FAILURE (R)	0	10	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	4	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	1	0	0	0	1
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	2	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	1	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	20	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	60	0	0	0	25
DETERIORATED	0	1	0	0	0	0
STUDY TOTAL	0	61	0	0	0	25
NON-EVALUATION RELATED	0	11	0	0	0	0
NON-EVALUATION UNRELATED	0	5	0	0	0	1
NON-EVAL PATIENT COMPLIC	0	3	0	20	0	0
TOTAL COUNT	0	80	0	20	0	26

ESTHETIC ACCEPTABILITY

	CAST CERAM PERIOD # 0	PERIOD # 1	MOLAR CAST CERAM PERIOD # 0	PERIOD # 1	PFM CONTROL PERIOD # 0	PERIOD # 1
ALPHA	79	78	20	20	26	26
BRAVO	1	1	0	0	0	0
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	0	0	0	0	0
STRUCTURE FAILURE (R)	0	1	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	0	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	0	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	79	0	20	0	26
DETERIORATED	0	0	0	0	0	0
STUDY TOTAL	0	79	0	20	0	26
NON-EVALUATION RELATED	0	1	0	0	0	0
NON-EVALUATION UNRELATED	0	0	0	0	0	0
NON-EVAL PATIENT COMPLIC	0	0	0	0	0	0
TOTAL COUNT	0	80	0	20	0	26

ESTHETIC ACCEPTABILITY

	CAST CERAM		MOLAR CAST CERAM		PFM CONTROL	
	PERIOD # 0	PERIOD # 2	PERIOD # 0	PERIOD # 2	PERIOD # 0	PERIOD # 2
ALPHA	79	71	20	20	26	26
BRAVO	1	1	0	0	0	0
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	0	0	0	0	0
STRUCTURE FAILURE (R)	0	4	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	2	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	2	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	72	0	20	0	26
DETERIORATED	0	0	0	0	0	0
STUDY TOTAL	0	72	0	20	0	26
NON-EVALUATION RELATED	0	4	0	0	0	0
NON-EVALUATION UNRELATED	0	2	0	0	0	0
NON-EVAL PATIENT COMPLIC	0	2	0	0	0	0
TOTAL COUNT	0	80	0	20	0	26

ESTHETIC ACCEPTABILITY

	CAST CERAM PERIOD # 0	PERIOD # 3	MOLAR CAST CERAM PERIOD # 0	PERIOD # 3	PFM CONTROL PERIOD # 0	PERIOD # 3
ALPHA	79	66	20	5	26	25
BRAVO	1	0	0	0	0	0
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	0	0	0	0	0
STRUCTURE FAILURE (R)	0	7	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	3	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	1
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	2	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	2	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	15	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	66	0	5	0	25
DETERIORATED	0	0	0	0	0	0
STUDY TOTAL	0	66	0	5	0	25
NON-EVALUATION RELATED	0	7	0	0	0	0
NON-EVALUATION UNRELATED	0	3	0	0	0	1
NON-EVAL PATIENT COMPLIC	0	4	0	15	0	0
TOTAL COUNT	0	80	0	20	0	26

ESTHETIC ACCEPTABILITY

	CAST CERAM PERIOD # 0	PERIOD # 4	MOLAR CAST CERAM PERIOD # 0	PERIOD # 4	PFM CONTROL PERIOD # 0	PERIOD # 4
ALPHA	79	61	20	0	26	25
BRAVO	1	0	0	0	0	0
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	1	0	0	0	0
STRUCTURE FAILURE (R)	0	10	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	4	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	1	0	0	0	1
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	2	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	1	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	20	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	61	0	0	0	25
DETERIORATED	0	0	0	0	0	0
STUDY TOTAL	0	61	0	0	0	25
NON-EVALUATION RELATED	0	11	0	0	0	0
NON-EVALUATION UNRELATED	0	5	0	0	0	1
NON-EVAL PATIENT COMPLIC	0	3	0	20	0	0
TOTAL COUNT	0	80	0	20	0	26

PERMANENCE OF SHADING PORCELAIN

	CAST CERAM		MOLAR CAST CERAM		PFM CONTROL	
	PERIOD # 0	PERIOD # 1	PERIOD # 0	PERIOD # 1	PERIOD # 0	PERIOD # 1
ALPHA	80	77	20	20	26	26
BRAVO	0	2	0	0	0	0
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	0	0	0	0	0
STRUCTURE FAILURE (R)	0	1	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	0	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATEL (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	0	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	77	0	20	0	26
DETERIORATED	0	2	0	0	0	0
STUDY TOTAL	0	79	0	20	0	26
NON-EVALUATION RELATED	0	1	0	0	0	0
NON-EVALUATION UNRELATED	0	0	0	0	0	0
NON-EVAL PATIENT COMPLIC	0	0	0	0	0	0
TOTAL COUNT	0	80	0	20	0	26

PERMANENCE OF SHADING PORCELAIN

	CAST CERAM PERIOD # 0	PERIOD # 2	MOLAR CAST CERAM PERIOD # 0	PERIOD # 2	PFM CONTROL PERIOD # 0	PERIOD # 2
ALPHA	80	70	20	20	26	26
BRAVO	0	2	0	0	0	0
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	0	0	0	0	0
STRUCTURE FAILURE (R)	0	4	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	2	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	2	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	70	0	20	0	26
DETERIORATED	0	2	0	0	0	0
STUDY TOTAL	0	72	0	20	0	26
NON-EVALUATION RELATED	0	4	0	0	0	0
NON-EVALUATION UNRELATED	0	2	0	0	0	0
NON-EVAL PATIENT COMPLIC	0	2	0	0	0	0
TOTAL COUNT	0	80	0	20	0	26

PERMANENCE OF SHADING PORCELAIN

	CAST CERAM		MOLAR CAST CERAM		PFM CONTROL	
	PERIOD # 0	PERIOD # 3	PERIOD # 0	PERIOD # 3	PERIOD # 0	PERIOD # 3
ALPHA	80	65	20	5	26	25
BRAVO	0	1	0	0	0	0
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	0	0	0	0	0
STRUCTURE FAILURE (R)	0	7	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	3	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	1
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	2	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	2	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	15	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	65	0	5	0	25
DETERIORATED	0	1	0	0	0	0
STUDY TOTAL	0	66	0	5	0	25
NON-EVALUATION RELATED	0	7	0	0	0	0
NON-EVALUATION UNRELATED	0	3	0	0	0	1
NON-EVAL PATIENT COMPLIC	0	4	0	15	0	0
TOTAL COUNT	0	30	0	20	0	26

PERMANENCE OF SHADING PORCELAIN

	CAST CERAM		MOLAR CAST CERAM		PFM CONTROL	
	PERIOD # 0	PERIOD # 4	PERIOD # 0	PERIOD # 4	PERIOD # 0	PERIOD # 4
ALPHA	80	60	20	0	26	25
BRAVO	0	1	0	0	0	0
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	1	0	0	0	0
STRUCTURE FAILURE (R)	0	10	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	4	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	1	0	0	0	1
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	2	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	1	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	20	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	60	0	0	0	25
DETERIORATED	0	1	0	0	0	0
STUDY TOTAL	0	61	0	0	0	25
NON-EVALUATION RELATED	0	11	0	0	0	0
NON-EVALUATION UNRELATED	0	5	0	0	0	1
NON-EVAL PATIENT COMPLIC	0	3	0	20	0	0
TOTAL COUNT	0	80	0	20	0	26

TISSUE COMPATIBILITY

	CAST CERAM		MOLAR CAST CERAM		PFM CONTROL	
	PERIOD # 0	PERIOD # 1	PERIOD # 0	PERIOD # 1	PERIOD # 0	PERIOD # 1
ALPHA	79	77	20	19	25	25
BRAVO	1	2	0	1	1	1
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	0	0	0	0	0
STRUCTURE FAILURE (R)	0	1	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	0	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	0	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	78	0	19	0	26
DETERIORATED	0	1	0	1	0	0
STUDY TOTAL	0	79	0	20	0	26
NON-EVALUATION RELATED	0	1	0	0	0	0
NON-EVALUATION UNRELATED	0	0	0	0	0	0
NON-EVAL PATIENT COMPLIC	0	0	0	0	0	0
TOTAL COUNT	0	80	0	20	0	26

TISSUE COMPATIBILITY

	CAST CERAM PERIOD # 0	PERIOD # 2	MOLAR CAST CERAM PERIOD # 0	PERIOD # 2	PFM CONTROL PERIOD # 0	PERIOD # 2
ALPHA	79	70	20	20	25	24
BRAVO	1	2	0	0	1	2
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	0	0	0	0	0
STRUCTURE FAILURE (R)	0	4	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	2	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	2	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	71	0	20	0	25
DETERIORATED	0	1	0	0	0	1
STUDY TOTAL	0	72	0	20	0	26
NON-EVALUATION RELATED	0	4	0	0	0	0
NON-EVALUATION UNRELATED	0	2	0	0	0	0
NON-EVAL PATIENT COMPLIC	0	2	0	0	0	0
TOTAL COUNT	0	80	0	20	0	26

TISSUE COMPATIBILITY

	CAST CERAM		MOLAR CAST CERAM		PFM CONTROL	
	PERIOD # 0	PERIOD # 3	PERIOD # 0	PERIOD # 3	PERIOD # 0	PERIOD # 3
ALPHA	79	64	20	5	25	23
BRAVO	1	2	0	0	1	2
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	0	0	0	0	0
STRUCTURE FAILURE (R)	0	7	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	3	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	1
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	2	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	2	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	15	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	65	0	5	0	24
DETERIORATED	0	1	0	0	0	1
STUDY TOTAL	0	66	0	5	0	25
NON-EVALUATION RELATED	0	7	0	0	0	0
NON-EVALUATION UNRELATED	0	3	0	0	0	1
NON-EVAL PATIENT COMPLIC	0	4	0	15	0	0
TOTAL COUNT	0	80	0	20	0	26

TISSUE COMPATIBILITY

	CAST CERAM		MOLAR CAST CERAM		PFM CONTROL	
	PERIOD # 0	PERIOD # 4	PERIOD # 0	PERIOD # 4	PERIOD # 0	PERIOD # 4
ALPHA	79	58	20	0	25	22
BRAVO	1	3	0	0	1	3
CHARLIE	0	0	0	0	0	0
DELTA	0	0	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	1	0	0	0	0
STRUCTURE FAILURE (R)	0	10	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	4	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	1	0	0	0	1
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	2	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	1	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	20	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	59	0	0	0	23
DETERIORATED	0	2	0	0	0	2
STUDY TOTAL	0	61	0	0	0	25
NON-EVALUATION RELATED	0	11	0	0	0	0
NON-EVALUATION UNRELATED	0	5	0	0	0	1
NON-EVAL PATIENT COMPLIC	0	3	0	20	0	0
TOTAL COUNT	0	80	0	20	0	26

OPPOSING OCCLUSION

	CAST CERAM		MOLAR CAST CERAM		PFM CONTROL	
	PERIOD # 0	PERIOD # 1	PERIOD # 0	PERIOD # 1	PERIOD # 0	PERIOD # 1
ALPHA	62	60	15	15	20	20
BRAVO	8	7	5	5	3	3
CHARLIE	9	10	0	0	3	3
DELTA	1	1	0	0	0	0
HOTEL	0	1	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	0	0	0	0	0
STRUCTURE FAILURE (R)	0	1	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	0	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	0	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	76	0	20	0	26
DETERIORATED	0	3	0	0	0	0
STUDY TOTAL	0	79	0	20	0	26
NON-EVALUATION RELATED	0	1	0	0	0	0
NON-EVALUATION UNRELATED	0	0	0	0	0	0
NON-EVAL PATIENT COMPLIC	0	0	0	0	0	0
TOTAL COUNT	0	80	0	20	0	26

OPPOSING OCCLUSION

	CAST CERAM PERIOD # 0	CAST CERAM PERIOD # 2	MOLAR CAST CERAM PERIOD # 0	MOLAR CAST CERAM PERIOD # 2	PFM CONTROL PERIOD # 0	PFM CONTROL PERIOD # 2
ALPHA	62	54	15	15	20	20
BRAVO	8	6	5	5	3	3
CHARLIE	9	11	0	0	3	3
DELTA	1	1	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	0	0	0	0	0
STRUCTURE FAILURE (R)	0	4	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	2	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	0
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	0	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	2	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	0	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	67	0	20	0	26
DETERIORATED	0	5	0	0	0	0
STUDY TOTAL	0	72	0	20	0	26
NON-EVALUATION RELATED	0	4	0	0	0	0
NON-EVALUATION UNRELATED	0	2	0	0	0	0
NON-EVAL PATIENT COMPLIC	0	2	0	0	0	0
TOTAL COUNT	0	80	0	20	0	26

OPPOSING OCCLUSION

	CAST CERAM		MOLAR CAST CERAM		PFM CONTROL	
	PERIOD # 0	PERIOD # 3	PERIOD # 0	PERIOD # 3	PERIOD # 0	PERIOD # 3
ALPHA	62	48	15	3	20	19
BRAVO	8	6	5	2	3	3
CHARLIE	9	11	0	0	3	3
DELTA	1	1	0	0	0	0
HOTEL	0	0	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	0	0	0	0	0
STRUCTURE FAILURE (R)	0	7	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	3	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	0	0	0	0	1
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	2	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	2	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	15	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	61	0	5	0	25
DETERIORATED	0	5	0	0	0	0
STUDY TOTAL	0	66	0	5	0	25
NON-EVALUATION RELATED	0	7	0	0	0	0
NON-EVALUATION UNRELATED	0	3	0	0	0	1
NON-EVAL PATIENT COMPLIC	0	4	0	15	0	0
TOTAL COUNT	0	80	0	20	0	26

OPPOSING OCCLUSION

	CAST CERAM PERIOD # 0	PERIOD # 4	MOLAR CAST CERAM PERIOD # 0	PERIOD # 4	PFM CONTROL PERIOD # 0	PERIOD # 4
ALPHA	62	45	15	0	20	19
BRAVO	8	3	5	0	3	3
CHARLIE	9	11	0	0	3	3
DELTA	1	1	0	0	0	0
HOTEL	0	1	0	0	0	0
========(RELATED REASONS)=========						
CARIES-RELATED (J)	0	1	0	0	0	0
STRUCTURE FAILURE (R)	0	10	0	0	0	0
VENEER FAILURE (K)	0	0	0	0	0	0
RETENTION FAILURE (M)	0	0	0	0	0	0
OPEN MARGIN (L)	0	0	0	0	0	0
EXCESSIVE WEAR (N)	0	0	0	0	0	0
INADEQUATE OCCLUSION (P)	0	0	0	0	0	0
PERIODONTAL COMPLIC (Q)	0	0	0	0	0	0
OTHER-RELATED (S)	0	0	0	0	0	0
=======(UNRELATED REASONS)========						
CARIES-UNRELATED (T)	0	0	0	0	0	0
FRACTURES-UNRELATED (U)	0	4	0	0	0	0
INADEQUATE ESTHETICS (V)	0	0	0	0	0	0
PROSTHETIC COMPLIC (W)	0	0	0	0	0	0
TOOTH MISSING (X)	0	0	0	0	0	0
OTHER UNRELATED (Y)	0	1	0	0	0	1
=====(PATIENT COMPLICATIONS)======						
DROPPED FROM STUDY (1)	0	0	0	0	0	0
HEALTH REASON (2)	0	0	0	0	0	0
SCHEDULING COMPLIC (3)	0	2	0	0	0	0
FEDERAL SERVICE (4)	0	0	0	0	0	0
UNABLE TO CONTACT (5)	0	1	0	0	0	0
BROKEN APPOINTMENT (6)	0	0	0	0	0	0
NO EVALUATION RECORD	0	0	0	20	0	0
IMPROVED	0	0	0	0	0	0
NO CHANGE	0	57	0	0	0	25
DETERIORATED	0	4	0	0	0	0
STUDY TOTAL	0	61	0	0	0	25
NON-EVALUATION RELATED	0	11	0	0	0	0
NON-EVALUATION UNRELATED	0	5	0	0	0	1
NON-EVAL PATIENT COMPLIC	0	3	0	20	0	0
TOTAL COUNT	0	80	0	20	0	26

DISTRIBUTION OF RATINGS

CRITERIA - MARGINAL ADAPTATION

						NOT EVALUATED		PATIENT	
	A	B	C	D	H	RELATED	UNRELATED	COMPLICATIONS	TOTAL
PERIOD NO. 0									
CAST CERAM	47	28	5	0	0	0	0	0	80
MOLAR CAST CERAM	18	2	0	0	0	0	0	0	20
PFM CONTROL	10	5	11	0	0	0	0	0	26
PERIOD NO. 1									
CAST CERAM	46	28	5	0	0	1	0	0	80
MOLAR CAST CERAM	18	2	0	0	0	0	0	0	20
PFM CONTROL	10	5	11	0	0	0	0	0	26
PERIOD NO. 2									
CAST CERAM	42	26	4	0	0	4	2	2	80
MOLAR CAST CERAM	18	2	0	0	0	0	0	0	20
PFM CONTROL	10	5	11	0	0	0	0	0	26
PERIOD NO. 3									
CAST CERAM	39	24	3	0	0	7	3	4	80
MOLAR CAST CERAM	4	1	0	0	0	0	0	15	20
PFM CONTROL	9	5	11	0	0	0	1	0	26
PERIOD NO. 4									
CAST CERAM	36	21	3	1	0	11	5	3	80
MOLAR CAST CERAM	0	0	0	0	0	0	0	20	20
PFM CONTROL	9	5	11	0	0	0	1	0	26

DISTRIBUTION OF RATINGS

CRITERIA - ESTHETIC ACCEPTABILITY

	A	B	C	D	H	NOT EVALUATED RELATED	NOT EVALUATED UNRELATED	PATIENT COMPLICATIONS	TOTAL
PERIOD NO. 0									
CAST CERAM	79	1	0	0	0	0	0	0	80
MOLAR CAST CERAM	20	0	0	0	0	0	0	0	20
PFM CONTROL	26	0	0	0	0	0	0	0	26
PERIOD NO. 1									
CAST CERAM	78	1	0	0	0	1	0	0	80
MOLAR CAST CERAM	20	0	0	0	0	0	0	0	20
PFM CONTROL	26	0	0	0	0	0	0	0	26
PERIOD NO. 2									
CAST CERAM	71	1	0	0	0	4	2	2	80
MOLAR CAST CERAM	20	0	0	0	0	0	0	0	20
PFM CONTROL	26	0	0	0	0	0	0	0	26
PERIOD NO. 3									
CAST CERAM	66	0	0	0	0	7	3	4	80
MOLAR CAST CERAM	5	0	0	0	0	0	0	15	20
PFM CONTROL	25	0	0	0	0	0	1	0	26
PERIOD NO. 4									
CAST CERAM	61	0	0	0	0	11	5	3	80
MOLAR CAST CERAM	0	0	0	0	0	0	0	20	20
PFM CONTROL	25	0	0	0	0	0	1	0	26

DISTRIBUTION OF RATINGS

CRITERIA - PERMANENCE OF SHADING PORCELAIN

	A	B	C	D	H	NOT EVALUATED RELATED	NOT EVALUATED UNRELATED	PATIENT COMPLICATIONS	TOTAL
PERIOD NO. 0									
CAST CERAM	80	0	0	0	0	0	0	0	80
MOLAR CAST CERAM	20	0	0	0	0	0	0	0	20
PFM CONTROL	26	0	0	0	0	0	0	0	26
PERIOD NO. 1									
CAST CERAM	77	2	0	0	0	1	0	0	80
MOLAR CAST CERAM	20	0	0	0	0	0	0	0	20
PFM CONTROL	26	0	0	0	0	0	0	0	26
PERIOD NO. 2									
CAST CERAM	70	2	0	0	0	4	2	2	80
MOLAR CAST CERAM	20	0	0	0	0	0	0	0	20
PFM CONTROL	26	0	0	0	0	0	0	0	26
PERIOD NO. 3									
CAST CERAM	65	1	0	0	0	7	3	4	80
MOLAR CAST CERAM	5	0	0	0	0	0	0	15	20
PFM CONTROL	25	0	0	0	0	0	1	0	26
PERIOD NO. 4									
CAST CERAM	60	1	0	0	0	11	5	3	80
MOLAR CAST CERAM	0	0	0	0	0	0	0	20	20
PFM CONTROL	25	0	0	0	0	0	1	0	26

DISTRIBUTION OF RATINGS

CRITERIA - TISSUE COMPATIBILITY

	A	B	C	D	H	NOT EVALUATED RELATED	NOT EVALUATED UNRELATED	PATIENT COMPLICATIONS	TOTAL
PERIOD NO. 0									
CAST CERAM	79	1	0	0	0	0	0	0	80
MOLAR CAST CERAM	20	0	0	0	0	0	0	0	20
PFM CONTROL	25	1	0	0	0	0	0	0	26
PERIOD NO. 1									
CAST CERAM	77	2	0	0	0	1	0	0	80
MOLAR CAST CERAM	19	1	0	0	0	0	0	0	20
PFM CONTROL	25	1	0	0	0	0	0	0	26
PERIOD NO. 2									
CAST CERAM	70	2	0	0	0	4	2	2	80
MOLAR CAST CERAM	20	0	0	0	0	0	0	0	20
PFM CONTROL	24	2	0	0	0	0	0	0	26
PERIOD NO. 3									
CAST CERAM	64	2	0	0	0	7	3	4	80
MOLAR CAST CERAM	5	0	0	0	0	0	0	15	20
PFM CONTROL	23	2	0	0	0	0	1	0	26
PERIOD NO. 4									
CAST CERAM	58	3	0	0	0	11	5	3	80
MOLAR CAST CERAM	0	0	0	0	0	0	0	20	20
PFM CONTROL	22	3	0	0	0	0	1	0	26

DISTRIBUTION OF RATINGS

CRITERIA - OPPOSING OCCLUSION

	A	B	C	D	H	NOT EVALUATED RELATED	NOT EVALUATED UNRELATED	PATIENT COMPLICATIONS	TOTAL
PERIOD NO. 0									
CAST CERAM	62	8	9	1	0	0	0	0	80
MOLAR CAST CERAM	15	5	0	0	0	0	0	0	20
PFM CONTROL	20	3	3	0	0	0	0	0	26
PERIOD NO. 1									
CAST CERAM	60	7	10	1	1	1	0	0	80
MOLAR CAST CERAM	15	5	0	0	0	0	0	0	20
PFM CONTROL	20	3	3	0	0	0	0	0	26
PERIOD NO. 2									
CAST CERAM	54	6	11	1	0	4	2	2	80
MOLAR CAST CERAM	15	5	0	0	0	0	0	0	20
PFM CONTROL	20	3	3	0	0	0	0	0	26

ANALYSIS OF FAILED CASTABLE CERAMIC CROWNS
MOLAR CROWNS

1.

Patient: 500179
Tooth No: 30 - Mandibular first molar
Age at Fracture: 21 Months
Origin of Fracture: Distal margin, 1.6mm min.
Clin Descript of Fract: Mesio-facial to distal, facial missing
Clinical Observations: The majority of this crown remained in function for one month after the fracture of the facial portion. There was a significant amount of shading porcelain present under the margin.

Crown Measurement:

	mm.		mm.
Crown Length=	5.2	Mesial Center=	2.1
Occl Pit, Min=	1.0	Distal Center=	1.5
Facial Center=	1.0	Funct Area Max=	1.7
Lingual Center=	1.6	Funct Area Min=	1.1

Prep Measurements:

	Reduction	Margin	Occl/Ging Height
Facial=	2.0	0.50	2.5
Mesial=	2.0	0.45	1.6
Lingual=	1.5	0.45	3.0
Distal=	1.8	0.60	2.0

Occl Clearance: Facial= 1.3 Lingual= 1.4

Type of Occlusion: Light overbite, very heavy bruxer
Preparation Descript: Margins very uneven in the facial-lingual and mesio-lingual direction and insufficient chamfer width.
Preparation Conclusion: Patient biting habit, i.e. very heavy bruxer.

2.

Patient: 500190
Tooth No: 14 - Maxillary first molar
Age at Fracture: 26 months
Origin of Fracture: Mesial margin, 1.4mm min.
Clin Descript of Fract: Mesio-facial to distal, facial 1/3 missing
Clinical Observations: Soon after this castable ceramic crown was placed, the patient had the opposing tooth crowned and anterior bridge work performed. The changes in this patient's occlusal relationship had caused an opening of the contact between tooth Nos. 14 and 15. At no time did the patient feel that the test crown on tooth No. 14 feel "high".

Crown Measurement:

	mm.		mm.
Crown Length=	5.7	Mesial Center=	1.4
Occl Pit, Min=	1.1	Distal Center=	1.5
Facial Center=	1.1	Funct Area Max=	1.7
Lingual Center=	1.0	Funct Area Min=	1.2

Prep Measurements:

	Reduction	Margin	Occl/Ging Height
Facial=	1.5	0.30	2.5
Mesial=	1.8	0.45	2.1
Lingual=	1.5	0.35	2.3
Distal=	1.7	0.50	2.3

Occl Clearance: Facial= 1.3 Lingual= 2.5

Type of Occlusion: Excessive overbite, anterior = 8-10mm, posterior = 5mm.

Preparation Descript: Uneven chamfer width, especially in the mesio-facial area.

Preparation Conclusion: Although this crown appears to have sufficient occlusal thickness, it is subject to heavy occlusal loading.

3. Patient: 500189

Tooth No: 19 - Mandibular first molar

Age at Fracture: 3 months

Origin of Fracture: Internal surface, center of occlusal area, 2.00mm at origin, 1.55mm min.

Clin Descript of Fract: Facial to lingual, mesial 1/2 missing.

Clinical Observations: A cement base was exposed in the mesio-lingual area of the preparations possibly giving less support to the crown. This was the last tooth in the patient's dental arch.

Crown Measurement:

	mm.		mm.
Crown Length=	5.5	Mesial Center=	2.3
Occl Pit, Min=	1.3	Distal Center=	2.0
Facial Center=	1.2	Funct Area Max=	1.9
Lingual Center=	1.1	Funct Area Min=	1.3

Prep Measurements:

	Reduction	Margin	Occl/Ging Height
Facial=	1.5	0.5	2.0
Mesial=	1.9	0.7	1.0
Lingual=	1.3	1.3	1.3
Distal=	1.5	1.5	2.0

Occl Clearance: Facial= 1.5 Lingual= 1.4

Type of Occlusion: Heavy group function

Preparation Descript: Insufficient resistance and retention form especially in the mesio-lingual area. Leverage in this area appears potentially high due to the small wall height in this area.

Preparation Conclusion: A combination of very heavy occlusal force plus insufficient tooth reduction in the mesio-lingual line angle.

4. Patient: 500196

Tooth No: 19 - Mandibular first molar

Age at Fracture: 12 months

Origin of Fracture: Check on the occlusal, 1.3mm at origin, 1.2mm min.

Clin Descript of Fract: Disto-lingual 1/3 missing

Clinical Observations: A thick shading porcelain layer of 200 microns was noted. An area of thick cement was also noted, suggesting incomplete crown seating.

Crown Measurement:

	mm.		mm.
Crown Length=	7.2	Mesial Center=	2.4
Occl Pit, Min=	1.3	Distal Center=	2.1
Facial Center=	1.0	Funct Area Max=	2.3
Lingual Center=	1.3	Funct Area Min=	1.3

Prep Measurements:

	Reduction	Margin	Occl/Ging Height
	Facial= 1.6	0.45	3.4
	Mesial= 2.0	0.6	2.2
	Lingual= 1.3	0.5	2.4
	Distal= 2.0	0.7	1.5

Occl Clearance: Facial= 1.5 Lingual= 1.5

Type of Occlusion: Relatively heavy overbite especially in the anterior region. Marked wear facets in centric and excursions. Removable partial denture on mandibular right side.

Preparation Descript: Acceptable chamfer with sufficient occlusal reduction.

Preparation Conclusion: Possible biting habit of chewing more on the left castable ceramic side due to removable partial denture on the right side.

5. Patient: 500192

Tooth No: 3 - Maxillary first molar

Age at Fracture: 15 months

Origin of Fracture: Internal occlusal, 1.6mm at origin, 1.2mm min.

Clin Descript of Fract: Mesial to distal, lingual 1/2 missing

Clinical Observations: The crown had a long facial surface and patient was chewing Nicotine gum at time of fracture.

Crown Measurement:

	mm.		mm.
Crown Length=	9.2	Mesial Center=	1.8
Occl Pit, Min=	1.3	Distal Center=	2.0
Facial Center=	1.4	Funct Area Max=	2.6
Lingual Center=	1.0	Funct Area Min=	1.3

Prep Measurements:

	Reduction	Margin	Occl/Ging Height
	Facial= 1.5	0.35	6.2
	Mesial= 2.0	0.60	1.7
	Lingual= 1.4	0.70	2.2
	Distal= 2.0	0.60	2.7

Occl Clearance: Facial= 1.7 Lingual= 2.2

Type of Occlusion: Acceptable group function

Preparation Descript: Non-uniform chamfer width, especially on the facial aspect. Large offset between facial and lingual wall heights which could cause a stress in the crown during fabrication.

Preparation Conclusion: Combination of preparation design and localized biting force from disto-lingual cusp of opposing tooth No. 30.

6. Patient: 500201

Tooth No: 31 - Mandibular second molar

Age at Fracture: 9 Months

Origin of Fracture: Occlusal surface, 1.4mm at origin, 1.4mm min.

Clin Descript of Fract: Disto-lingual 1/4 missing

Clinical Observations: This was the only second molar in the study. There was pitted occlusal wear in the fracture region and a balloon shaped pattern on the fracture surface suggesting a point load which initiated the fracture.

Crown Measurement:		mm.		mm.
	Crown Length=	6.6	Mesial Center=	1.8
	Occl Pit, Min=	1.1	Distal Center=	1.7
	Facial Center=	1.5	Funct Area Max=	2.5
	Lingual Center=	1.3	Funct Area Min=	1.1

Prep Measurements:	Reduction	Margin	Occl/Ging Height
	Facial= 1.2	0.45	2.9
	Mesial= 2.0	0.50	2.0
	Lingual= 1.2	0.50	2.0
	Distal= 2.0	0.70	1.5

Occl Clearance: Facial= 1.8 Lingual= 1.5

Type of Occlusion: Moderate to heavy bruxer with group function

Preparation Descript: Chamfer uniform in width and acceptable

Preparation Conclusion: Fracture resulting from localized heavy occlusion on mesio-lingual cusp of No. 2.

ANALYSIS OF FAILED CASTABLE CERAMIC CROWNS
PREMOLAR CROWNS

1\. Patient: 353985.
Tooth No: 13 - Maxillary second premolar
Age at Fracture: 14 months
Origin of Fracture: Internal distal chamfer, 0.95mm min.
Clin Descript of Fract: Mesial to distal, lingual 1/2 missing
Clinical Observations: This patient was a bruxer, and when patient was asked to clench and grind his teeth, movement of the premolars was visible. A thick 200 micron shading porcelain layer was noted.

Crown Measurement:

	mm.		mm.
Crown Length=	1.3	Mesial Center=	2.2
Occl Pit, Min=	1.1	Distal Center=	1.9
Facial Center=	1.2	Funct Area Max=	1.6
Lingual Center=	1.1	Funct Area Min=	1.1

Prep Measurements:

Reduction	Margin	Occl/Ging Height
Facial= 1.5	0.40	4.8
Mesial= 2.0	0.50	2.0
Lingual= 2.0	0.30	3.5
Distal= 1.5	0.60	2.0

Occl Clearance: Facial= 1.6 Lingual= 1.4
Type of Occlusion: Deep anterior overbite with heavy wear facets on the test restoration side.
Preparation Descript: Preparation designed like full veneer crown
Preparation Conclusion: Heavy wear facets indicative of high occlusal force application.

2\. Patient: 243448.
Tooth No: 21 - Mandibular first premolar
Age at Fracture: 10 months
Origin of Fracture: Distal margin, 1.4mm at origin, 1.3mm min.
Clin Descript of Fract: Mesio-facial to distal, facial 1/3 missing
Clinical Observations: The crown had a short gingivo-occlusal height, first and second molars were missing which forced molar type of chewing forward to the premolars, and there was an opposing plunger cusp. There was also shading porcelain beyond the margin in the distal crack origin.

Crown Measurement:

	mm.		mm.
Crown Length=	6.6	Mesial Center=	1.4
Occl Pit, Min=	0.8	Distal Center=	1.5
Facial Center=	0.9	Funct Area Max=	2.2
Lingual Center=	0.9	Funct Area Min=	1.8

Prep Measurements:

Reduction	Margin	Occl/Ging Height
Facial= 1.2	0.60	4.0
Mesial= 1.7	0.30	1.8
Lingual= 1.0	0.25	3.4
Distal= 1.5	0.45	2.0

Occl Clearance: Facial= 2.5 Lingual= 1.3

Type of Occlusion:	Partially edentulous with maximum anticipated occlusal force applied on test castable ceramic crown.
Preparation Descript:	Insufficient reduction on the lateral wall areas.
Preparation Conclusion:	Excessive occlusal force combined with insufficient lateral tooth reduction.

3\. Patient: 500205

Tooth No:	13 - Maxillary second premolar
Age at Fracture:	31 months
Origin of Fracture:	No fracture
Clin Descript of Fract:	No fracture
Clinical Observations:	Caries under the lingual margin which suggests incomplete cementation or incomplete caries excavation during crown preparation. The shoulder type of preparation would contribute to rapid spread of caries.

Crown Measurement:

	mm.		mm.
Crown Length=	7.2	Mesial Center=	2.0
Occl Pit, Min=	1.2	Distal Center=	1.5
Facial Center=	1.1	Funct Area Max=	1.4
Lingual Center=	1.2	Funct Area Min=	1.2

Prep Measurements:

	Reduction	Margin	Occl/Ging Height
Facial=	1.0	0.45	4.4
Mesial=	2.0	0.30	2.1
Lingual=	1.3	0.50	3.5
Distal=	1.5	0.50	2.4

Occl Clearance: Facial= 1.3 Lingual= 1.5

Type of Occlusion:	Very heavy group function with heavy wear facets in the molar areas, especially on teeth #15 & 18.
Preparation Descript:	Acceptable taper distally and lingually. Over tapper mesially and facially. Occlusal clearance was insufficient in the mesial and disto-lingual areas with a plunging mesio-lingual cusp of #30. Chamfer width was minimal in the mesio-facial line angle.
Preparation Conclusion:	Despite the fact that several factors could have explained why this crown should have fractured, it did not fracture, and failure was due to caries.

4\. Patient: 309628

Tooth No:	4 - Maxillary second premolar
Age at Fracture:	37 months
Origin of Fracture:	No fracture report available
Clin Descript of Fract:	Mesial to distal, lingual 1/3 missing
Clinical Observations:	The portion of the crown that remained cemented was smoothed off by the patient's private dentist. All recovered fragments have been forwarded to Corning for fracture analysis.

Crown Measurement:

	mm.		mm.
Crown Length=	7.4	Mesial Center=	1.5
Occl Pit, Min=	1.0	Distal Center=	1.2
Facial Center=	1.0	Funct Area Max=	2.0
Lingual Center=	0.8	Funct Area Min=	1.5

Prep Measurements:

	Reduction	Margin	Occl/Ging Height
Facial=	1.2	0.50	4.2
Mesial=	2.0	0.50	2.8
Lingual=	1.4	0.45	2.9
Distal=	2.0	0.40	2.1

Occl Clearance: Facial= 1.8 Lingual= 1.7

Type of Occlusion: Moderate bruxer with group function and tight bite.

Preparation Descript: Acceptable chamfer width; disto-lingual has a sharp angle.

Preparation Conclusion: Combination of sharp line angle and heavier posterior bite.

5. Patient: 361427

Tooth No: 20 - Mandibular second premolar

Age at Fracture: 35 months

Origin of Fracture: Internal occlusal, 0.9mm min.

Clin Descript of Fract: Mesio-lingual to distal, lingual 1/3 missing

Clinical Observations: The second premolar was the last tooth in the arch. A portion of the build-up was lost and the crown was supported in the area of fracture by a thick cement layer.

Crown Measurement:

	mm.		mm.
Crown Length=	6.4	Mesial Center=	2.0
Occl Pit, Min=	0.8	Distal Center=	1.8
Facial Center=	1.3	Funct Area Max=	1.8
Lingual Center=	1.2	Funct Area Min=	1.8

Prep Measurements:

	Reduction	Margin	Occl/Ging Height
Facial=	2.1	0.60	3.6
Mesial=	2.8	0.45	2.4
Lingual=	1.4	0.40	3.5
Distal=	1.8	0.50	3.1

Occl Clearance: Facial= 1.0 Lingual= 1.0

Type of Occlusion: Very heavy contact on occluding teeth with large wear facets. Fulcrum of occlusion was on the test castable ceramic crown which was the last tooth in the arch. Patient was partially edentulous.

Preparation Descript: Width of the chamfer was adequate except on the mesio-lingual aspect where it was very narrow. Occlusal clearance appeared adequate.

Preparation Conclusion: Combination of high biting force and possible insufficient lingual reduction.

ANALYSIS OF FAILED CASTABLE CERAMIC CROWNS
ANTERIOR CROWNS

1\. Patient: 500182

Tooth No: 8 - Maxillary central incisor

Age at Fracture: 38 months

Origin of Fracture: No fracture report available

Clin Descript of Fract: Mesio-facial

Clinical Observations: The patient noted a crack in his tooth and although the crown was still intact, we elected to section and remove the crown before complete failure of the crown. The crown was supported by a post and composite core build-up.

Crown Measurement:

	mm.		mm.
Crown Length=	10.5	Mesial Center=	1.6
Occl Pit, Min=	3.0	Distal Center=	1.5
Facial Center=	1.0	Funct Area Max=	1.0
Lingual Center=	1.0	Funct Area Min=	0.9